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# THESIS

**RAPID, VALUE-BASED, EVOLUTIONARY ACQUISITION AND ITS APPLICATION TO A USMC TACTICAL SERVICE ORIENTED ARCHITECTURE**

by

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June 2009

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Over budget, behind schedule, and underperforming information technology acquisition programs plague not only the USMC, but almost all government agencies and many private sector entities as well. Causes of this crisis abound and one cannot easily or narrowly define them because of their seemingly disparate and far-reaching nature. This thesis first defines what truly constitutes an acquisition program's success versus its failure and then analyzes general causes of project failure, focusing on lack of both value and timeliness. Rapid, value-based, evolutionary acquisition (RVEA) is introduced as an improved acquisition method compliant with current government rules and regulations that could help reduce the causes of such failure. RVEA focuses on the characteristics of user-defined value, cyclic rapidity, and continual improvement through systematic evolution. The foundation of these attributes is comprehensively described in a comparison with the ideals found in the process of attaining information superiority. The thesis concludes with recommendations for acquisition action officers through a discussion of RVEA's application to the potential acquisition of a Tactical Service Oriented Architecture for the USMC.

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**RAPID, VALUE-BASED, EVOLUTIONARY ACQUISITION AND ITS APPLICATION TO A USMC TACTICAL SERVICE ORIENTED ARCHITECTURE**

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# ABSTRACT

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# ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| ACM | Air Combat Maneuvering |
| AFATDS | Advanced Field Artillery Tactical Data System |
| $A_{iv}$ | Information Value Availability |
| $A_{nr}$ | Net-Ready Availability |
| $A_o$ | Operational Availability |
| C2PC | Command and Control Personal Computer |
| CAS | Close Air Support |
| CCA | Clinger-Cohen Act |
| CDR | Critical Design Review |
| CJCSI | Chairman of the Joint Chiefs of Staff Instruction |
| COTS | Commercial-Off-The-Shelf |
| CTE | Critical Technical Elements |
| DAS | Defense Acquisition System |
| DoD | Department of Defense |
| DoDI | Department of Defense Instruction |
| EA | Evolutionary Acquisition |
| EMD | Engineering and Manufacturing Development |
| FAR | Federal Acquisition Regulation |
| GAO | Government Accountability Office |
| HMMWV | High Mobility Multi-purpose Wheeled Vehicle |
| IED | Improvised Explosive Device |
| IPv6 | Internet Protocol version 6 |
| IT | Information Technology |
| JADOCS | Joint Automated Deep Operations Coordination System |
| JCIDS | Joint Capabilities Integration and Development System |
| JROC | Joint Requirements Oversight Council |
| JTRS | Joint Tactical Radio System |
| KPP | Key Performance Parameter |
| KSA | Key System Attribute |
| MEWSS | Mobile Electronic Warfare Support System |
| MILSPEC | Military Specification |
| MLDT | Mean Logistics Delay Time |
| MOE | Measure Of Effectiveness |
| MOS | Military Occupational Specialty |
| MTBF | Mean Time Between Failure |
| MTTR | Mean Time to Repair |
| NCA | National Command Authority |
| NFCS | Naval Fire Control System |
| NGF | Naval Gun Fire |
| ONR | Office of Naval Research |
| OODA | Observe, Orient, Decide, Act |
| OT&E | Operational Test and Evaluation |

| | |
|---|---|
| PFED | Pocket-sized Forward Entry Device |
| PMO | Program Management Office |
| PPBES | Planning, Programming, Budgeting and Execution System |
| QoS | Quality of Service |
| RFI | Request For Information |
| RVEA | Rapid, Value-based, Evolutionary Acquisition |
| S&T | Science and Technology |
| SOA | Service Oriented Architecture |
| SSFC | Single Step to Full Capability |
| TBMCS | Theater Battle Management Core Systems |
| TD | Technical Description |
| TLDHS | Target Location, Designation and Handoff System |
| TSOA | Tactical Service Oriented Architecture |
| USMC | United States Marine Corps |
| VIRT | Valued Information at the Right Time |
| VoE | Value of Enhancement |
| VoS | Value of Service |
| W2COG | World Wide Consortium for the Grid |
| WEEMC | Web-Enabled Execution Management Capability |
| WI | W2COG Institute |

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# I. INTRODUCTION

## A. PURPOSE

This thesis formulates, examines and illustrates specific principles of acquisition management designed to increase the probability of successful acquisition of Defense-related information systems. A Tactical Service Oriented Architecture (TSOA) for the United States Marine Corps (USMC), as a concept on its way to an acquisition program of record, illustrates the principles of this management strategy. The recommendations conveyed in this thesis have applicability to not only the acquisition of a USMC TSOA, but also to Department of Defense (DoD) Information Technology (IT) acquisition in general.

## B. OBJECTIVES

This thesis has several objectives. Directly related to the stated purpose above, the primary objective suggests an improved approach to DoD acquisition of IT systems, using value-based logic and ready for immediate implementation by the Services. (Hereafter, Services with a capital 'S' refers to the branches of U.S. military services – the Army, Navy, Air Force, and Marine Corps – and the U.S. Coast Guard.) As a secondary objective, this thesis illustrates the application of this acquisition approach to a subject of direct interest to the USMC: Tactical Service Oriented Architecture. Additionally, in order to build foundational background and support for the primary and secondary objectives above, this thesis includes an analysis of DoD IT program success versus failure.

## C. RELEVANCE

The topic of an improved approach for the acquisition of DoD information systems emerged through the research of material provided by the Marine Corps Systems Command in Quantico, Virginia, in its pursuit of expertise on Service Oriented Architectures (SOAs). In April 2008, the Marines published a request for information (RFI) that solicited:

> …ideas, initiatives, and/or processes [related to the] governance, development, and operation of Service Oriented Architectures (SOA) within the United States Marine Corps at the tactical and enterprise levels. (FedBizOpps.gov, 2008)

The RFI explains that the solicitation results from DoD direction (DoDD 8320.02, 2004) to migrate legacy IT architectures to SOAs to the greatest extent possible and to the lowest level tactically possible. Marine Corps leadership is approaching this daunting task with skeptical apprehension as evident in the RFI's additional statement, "…if not implemented correctly, the transition to a SOA will greatly disrupt operations at the tactical and enterprise level, increase costs, and adversely affect combat efficiency."

The Marine Corps and other government agencies maintain justifiable uneasiness in implementing a "solution" that will have effects—positive or negative—across the board, both on enterprise and edge (tactical) users. Failure in this acquisition endeavor potentially looms in the distance, and, if realized, failure would have lasting disruptive consequences. Improving the manner in which we, the DoD, develop and procure our IT systems, will reduce the chances of such failure. Subsequent chapters reveal sound principles for DoD IT acquisitions that accomplish this improvement.

## D. THESIS QUESTIONS

This thesis focuses on IT acquisition management. As such, it aims to answer one primary question involving IT acquisition in the DoD and the Marine Corps, and three secondary questions, the first two of which help define Defense acquisition project success. The last secondary question relates to the acquisition of a USMC TSOA. The questions posed are:

1. Primary Research Question:
    a. What are the essential principles of acquisition to successfully deliver valued capabilities to the warfighter?
2. Secondary Research Questions:
    a. What defines acquisition project success and failure, and what causes one's failure?

b. How does the concept of timeliness fit in the equation for acquisition value?

c. How can the USMC apply the essential principles of rapid, value-based, evolutionary acquisition to the development and procurement of a TSOA?

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# II. BACKGROUND

## A. JUSTIFIABLE APPREHENSION

The USMC, DoD, and businesses worldwide are approaching IT projects with increasing trepidation… and rightfully so. Failed IT acquisition projects costing investors and taxpayers billions of dollars annually litter the path to “improvement” much to the dismay of well-intended, experienced and knowledgeable project managers and executives. According to a 2005 study, organizations will completely abandon 5-15% of all IT projects before or shortly after delivery (Charette, 2005). These numbers appear optimistic when considering another 2005 study, which states that only 10% of 250 different projects reviewed successfully achieved their stated objectives for cost, schedule and quality (Jones C. , 2004). While the other 90% of those projects did not totally fail, a startling 9 out of 10 never achieved their goals! Yet another interesting generalization says 25% of all IT projects fail, 25% succeed, and the other 50% fall somewhere between success and failure (Kozak-Holland, 2007). These statistics vary, but they all grab our attention because of the staggering failure rates. Technology professionals in the public and private sector alike fully recognize these facts and yet the struggles continue in the area of IT project management and acquisition.

The Defense Department has no immunity to this plague. Nearly all major defense acquisition programs today include a significant amount of software and IT. The Marine’s MV-22 Osprey for example contains over 10 million lines of code and the Joint Strike Fighter over 11 million. Without their complex suite of computerized flight control systems which significantly rely on IT, neither would fly, much less accomplish their stated missions. This complexity has contributed to schedule delays, cost overruns, or even program cancellation in the case of the Navy’s A-12 carrier-based attack aircraft (Stevenson, 2001). Not limited to aviation, these problems contributed to the ineffectiveness and eventual cancellation of the U.S. Army’s M247 Sergeant York anti-aircraft gun in 1985.

More currently, the Army's highly complex Future Combat Systems program with its estimated 32 million lines of code struggles with increasing costs and lagging schedules. These types of delays, overruns, and other programmatic problems combined with unsatisfactory performance or flat-out system failures have led the U.S. Government Accountability Office (GAO) to designate the DoD systems development and modernization efforts as a "high-risk area" (GAO/HR-99-1, 1999). One must ask… Why?

## B. PROJECT SUCCESS AND FAILURE DEFINED

Before analyzing the causes of such a dismal performance record for IT acquisition, the context of this thesis requires a more concise definition of project success and failure as the terms apply to DoD systems acquisitions. Without a clear understanding of the meanings of the words, analysis of their causes and application of potential solutions stretches to impossibility. After solidifying these definitions, they will serve as reference points throughout the remainder of this thesis.

### 1. Part of the Problem: A Lack of Definition of Success

Lacking a distinct definition of success and failure, a project will most likely never attain and avoid each respectively.

> The big problem with assessing project success is that it is not precise… This dynamic can often be the Achilles heel for a project. Without a dependable understanding of what constitutes success, the project is placed in the untenable position of being judged against differing criteria, and invariably becomes one more failure statistic reported by research firms… (O'Brochta, 2002)

The North American English Encarta Dictionary characterizes success as the achievement of something planned or attempted. But what exactly defines that "something" for an IT project?

IT projects typically have multiple goals and objectives. Which one or ones really count hinges on opinion and varies widely depending on the domain and the stakeholder's position of interest within or relative to that domain. For instance, a performance objective of an IT project in the domain of a private sector business may include streamlining a process in order to increase efficiency. An example of such a project is the development and employment of an airline's self-check-in system intended to decrease customer wait times by a certain percentage. This same project most likely would have internal cost and schedule goals for its implementation in addition to its performance goals. In the end, if the project runs a bit over budget and begins operation a few weeks behind schedule but still meets its performance objectives, upper level management would probably categorize it as a success, even though it did not meet all of its objectives. (Note the project manager however, as a different stakeholder may have another opinion and consider it a personal failure since cost and schedule goals, as his responsibility, missed the mark.) Now considering another outcome, if it met its budget and time objectives but failed to meet its performance goal to decrease customer wait times, all stakeholders would probably consider it a failed project. Why? Because in this case and others in the private sector, the reason for failure classification is often easy to understand: "Success for the commercial world is straightforward and simple: maximize profit." (GAO-06-110, 2006) Private sector businesses conceive projects in order to improve the bottom line, through either cutting costs or increasing revenue, and a business would most likely not consider a venture project unless it has the potential to generate positive returns.[1] In our example above, the likely intent of the airline self-check-in system might include improving the customers' experience, resulting in repeat business, which would in turn increase revenue. Or perhaps the company intended to reduce the number of

[1] This is an intentional oversimplification and not intended to convey that all businesses are purely self-promoting entities that do not participate in other worthwhile activities that might not necessarily generate profit. Examples of these activities include those which improve public image, improve employee health, contribute to worthy community or charitable causes, etc.

employees behind the check-in counter, which would decrease costs. Either way, both of these desired results affect the company's financial bottom line, which truly determines success or failure upon completion of a commercial project.

Unfortunately, project success in a public sector organization such as the Defense Department eludes such clear definition, and this fact leads to problems. Taking a simplistic view when comparing DoD to commercial systems acquisition, success's definition initially appears similar: deliver a product that meets the requirements, on time and for the right price. Further investigation, however, reveals the implied definition for success at least in the DoD complicates the matter. Often a program's ability to attract funds for itself and other projects defines success, instead of the program meeting any real objectives. Project managers on both the government and defense contractor sides accomplish this through overly optimistic cost and schedule estimates or by avoiding or delaying reports of bad news that might decrease a program's funding line (GAO-06-110, 2006). The figure below shows a comparison of commercial project success versus DoD project success and the resulting behaviors as reported by the GAO.

| | Commercial companies | DOD |
|---|---|---|
| Success | Sale to customer. | Attracting funds. |
| Means to success | Strategic planning/prioritizing. | Competition for funds. |
| | Realism and candor. | Optimism and unknowns. |
| | Early testing. | Late testing. |
| | Early redlights, greenlights based on demonstration. | Early greenlights; late redlights. |
| | Collaboration and trust. | Oversight and distrust. |
| | Senior leaders are program advocates. Corporate research departments are technology developers. Program manager is executor. | Program manager is often the advocate, technology developer, and executor. |
| | Single program manager is accountable for delivery. | Multiple program managers are accountable for continuation. |

Source: GAO.

**Figure 1. Differences in Definition of Success and Resulting Behaviors (From GAO-06-110)**

According to the Under Secretary of Defense for Acquisition, Technology and Logistics, "… the enterprise will often pressure acquisition teams and industry to provide low, optimistic estimates to help start programs." (Young, 2009) These overly optimistic cost, schedule and performance estimates ultimately hurt any program because the eventual application of *realistic* estimates reveal a program unexpectedly in a cost overrun, behind schedule and failing to meet performance objectives. This sometimes occurs when a program commences its critical early stages. If a program survives such a disadvantaged initiation, it most likely will produce a sub-par performing system in the hands of the end user – the warfighter in tactical domain of the DoD. Nevertheless, was this program a success? Unlike the commercial world, a simple measurement of profit or loss does not answer this question. Nor does the ability of the project to "stay alive" and continue attracting funding support determine success. Instead, value delivered to the customer determines the true success or failure of a tactical DoD system.

### 2. DoD Acquisition Program Success vs. Failure

The warfighter who ultimately will use a tactical system wants that system to contribute to his or her mission. The ability of that system to contribute value to the warfighter's task defines success for that class of stakeholders. Thus, value delivered by that system equates to success. The system can contribute in many different ways. Perhaps it lightens a load, improves communications ability, increases decision-making effectiveness, or improves survivability. Since the warfighter considers value-adding systems or products successes, one should, by the same token, consider the projects or programs which developed and procured them successful. Similarly, the warfighter also determines project failure. If a fielded system improves no aspect of a warfighter's job, it fails. This judgment of failure depends not on coming in over budget or behind some arbitrary programmatic schedule. Instead, it rests on the system not satisfying user-defined quality attributes on the user's timeline. Simply stated, if the system does not provide value to the warfighter when needed, it and the program responsible for its development and procurement both fail.

This does not imply the warfighter is the *only* stakeholder in a tactical system. On the contrary, we must recognize the fact that every American from the top down retains some interest in such a project. For instance, the U.S. Congress allocates a program's funding and measures its ability to remain on schedule and on budget. The DoD and its associated projects sometimes directly or indirectly employ the constituents of these Congressmen and women. The program management team and responsible contractors have interests in seeing their program reach operational status. And of course, the American taxpayers, in support of national defense, provide funding for all DoD projects. As rightful stakeholders, these people all share valid inputs, concerns, and interests, but they do not determine the success or failure of a program. Ultimately, only the end user—the warfighter—can declare true success or failure of a tactical system.

The first increment (Block 1) of the Target Location, Designation and Handoff System (TLDHS) illustrates a warfighter's determination of success vs. failure. The system boasted innovative and impressive capabilities as it allowed a Forward Air Controller to precisely determine the location of a target and digitally send this location to a Close Air Support (CAS) aircraft overhead for prosecution. These features minimized voice communications and consequently decreased the chances of miscommunication. Unfortunately, the warfighter (the FAC) did not value Block 1 of the system because it lacked usability. Because of its weight and bulk, warfighters found it difficult to carry. They also had trouble reading its display in sunlight. Its magnetic compass made it impossible to use near vehicles. Additionally, it required a lengthy and involved setup process that included multiple cables, attachments, and a slow processor boot up. Because of these and other limitations, the user did not value the system. Its lack of usability far outweighed the benefits it offered in locating targets and minimizing communications, and without necessarily saying so, the warfighters considered it a failure as just another 40 lbs. of gear they had to carry and account for.

The many qualitative and quantitative definitions of project success and failure both in the private and public sectors vary widely. In the business of warfighting though, the definitions break down into relatively simple terms: success = value added for the user; failure = no value added.

## C. WHY DO DOD IT SYSTEMS FAIL TO SATISFY THE WARFIGHTER?

With firm definitions of project success versus failure, this section will examine some of the causes of such failure. It will first review some of the more universal causes of project or program failure and then narrow the scope to look at the challenges faced by the government, specifically DoD, acquisition programs and why they fail to deliver user-valued products.

### 1. Causes of "Failure" Abound

Using a more generic definition of project failure than the warfighter's described above, IT projects fail for a number of different reasons or combination of reasons. Various organizations and experts have analyzed this subject for decades and their studies usually produce lists of factors that contribute to project failure. A 1994 Standish CHAOS Report concluded the following as top factors in failed projects (Frese & Sauter, 2003). Although almost 15 years old, this list preserved comprehensive and relevant points that still contribute to project failures today.

- Incomplete requirements
- Lack of user involvement
- Lack of resources
- Unrealistic expectations
- Lack of executive support
- Changing requirements and specifications
- Lack of planning
- Project no longer needed
- Lack of IT management
- Technical illiteracy

Other contributors not listed in the report deserve at least mentioning. For example, developers often inadequately understand user needs (Field, 1997) or the users poorly communicate their needs to the IT development team (Hoffman, 2003). Additionally, information system projects often take place in an environment characterized by the following, “[a] lack of management continuity and an incentive system that encourages overly optimistic estimates of the benefits that can be attained from doing the project.” (Hulme, 1997)

Acquisition programs in the DoD are simply projects (albeit far from simple though) and as such involuntarily expose themselves to failure due to the above causal factors. Unfortunately, DoD projects face those obstacles as well as many others not typically encountered by private industry. Considering the organizational size and complexity of the DoD and the defense industry, the following factors additionally challenge the success of their IT projects.

- Inter-Service rivalry and competition
- Lack of personnel continuity (GAO-08-782T, 2008)
- Ill-responsive requirements and budget process (GAO-08-782T, 2008)
- Dislocated, uninformed and disinterested user community
- Inexperienced or unqualified acquisition workforce (GAO-08-1159T, 2008)
- Event-driven projects executing a time-driven budget
- Onerous oversight via rules, regulations and reporting requirements (GAO-06-110, 2006)
- Numerous integration and interoperability requirements
- Risk and change averseness
- Failure averseness (inability to dismiss sunk costs) (GAO-08-379, 2008)
- Lack of user training
- Lack of post-deployment support
- Self-gratifying and inappropriately motivated incentive system (GAO-08-782T, 2008)
- Overly optimistic cost and schedule estimates (GAO-06-110, 2006)

### 2. Why Do Projects Fail to Provide Value to the User?

The lists above offer some insight into the causes of generic project failure. Narrowing the scope of this analysis, consider the warfighter's definition of failure as described in the preceding sections. Using that definition, why would a project fail, or more precisely, why would a system not deliver value to the user? The reasons logically divide into two broad categories: either (1) some aspect of the system does not provide value to the user or worse, hinders the user, or (2) the system did not meet the user's required timeline.

#### *a. Causes of Failure – System Aspects*

The first category is relatively simple – the intended user finds no satisfaction due to a shortfall of the system relative to their needs or desires. These user goals cover a broad spectrum of system requirements related to its performance and physical characteristics, such as usability, reliability, transportability, maintainability, etc. Inadequacies in these areas contribute to project failure because they devalue the system in the eyes of the user. Obviously, different levels of consequence exist in this category. On one extreme as an example, the system burdens more than benefits the user and as a result, it actually decreases the warfighter's effectiveness and retains no value whatsoever. At the other end of the spectrum, the system takes on some, but not much value. An example of this could include a lack of organizational support for a decent system because of inadequate training or spare repair parts. These relate to a failure of some aspect of the system itself, and they all reduce the value the user places on it, thereby increasing its chance of ultimate failure.

#### *b. Causes of Failure – Lack of Timeliness*

The second category of contributions to tactical IT project failure is more abstract than the first, but it cripples a project just as much, if not more so. These factors relate to the speed at which value reaches the user. Before the 1990s, system design used a traditional waterfall approach or a single step to full capability (SSFC). This process identified a capability gap; developed an item to fill that gap; built, tested, fielded it and subsequently supported it for the next few decades until the product reached its end and required replacement. This slow process worked well for hardware intensive systems where the identified capability gap, or target, stayed relatively stationary and immune to technological volatility. Programs did not rush to complete the project because the target remained when the piece of hardware rolled off the production line. For example, the legacy military Jeep and its replacement, the High Mobility Multi-purpose Wheeled Vehicle (HMMWV) well illustrate this. The acquisition target, or desired capability of lightweight vehicular transportation, persisted throughout the HMMWV's development and production, and was therefore relatively easy to hit. Ultimately the users valued the product because the requirement defined in 1981 remained valid through system delivery in 1985 and beyond. The program hit the target and the military considered it a success.

However, since then software has assumed many functions historically accomplished by hardware. IT now permeates most military systems, and as a result, the SSFC method of acquisition has become less appropriate. Today, the target no longer cooperates by remaining stationary because of the rapid rate of technological change. Timeliness of acquisition has pervaded its way into the equation for project success. Using a slow, inflexible process to develop and produce an IT system likens to taking slow, methodical aim at a distant, randomly moving target. This equates to a kiss of death for an IT project because of the target's seemingly unpredictable movements, and the system will never succeed in its aim. By the time the system achieves delivery, the target has changed and the user will not value it (e.g. it fails) for multiple reasons. The paragraphs below provide details on some of these reasons.

(1) Project No Longer Needed. Determining a formal requirement for a DoD acquisition program requires time, sometimes years. The Joint Capabilities Integration and Development System (JCIDS) process provides the means to "ensure the joint warfighter receives the capabilities required to successfully execute the missions assigned to them" (CJCSI 3170.01F, 2007). Unfortunately, this process takes an exorbitant amount of time and requires numerous approvals before finalization of a formal requirements document. The requirement feeds the Defense Acquisition System, which translates the desired capability into an acquisition program (DoDI 5000.02, 2008).

The time required to develop and produce a system varies greatly depending on a number of different factors including the system's complexity, technological maturity, and the number of stakeholders, to name a few. Throughout this prolonged process of identifying a requirement, acquiring program funding, developing and finally producing a system, the requirement likely will change... possibly due to an environmental or technological change or any one of a number of other reasons. As a hypothetical example, a radio frequency jamming device intended to counter wirelessly detonated improvised explosive devices (IEDs) becomes operational *after* insurgents have switched tactics and now detonate their IEDs using some other means. The user views the jammer as irrelevant and unsuccessful even though it may effectively jam detonation signals. Due solely to its tardiness, the system fails because it burdens users as yet another item they have to account for, train on, maintain, transport, store, etc. In these situations, no system at all provides more value than a late system. As General James Cartwright, the Vice Chairman of the Joint Chiefs of Staff said, "It takes longer to declare a new [program] start than the lifecycle of the software package." (Boessenkool, 2009) Rapid change truly marks the information age, and slow-developing IT systems often reach users only to fail in satisfying recently changed or invalidated requirements. The user does not need the tactical system provided and disappointment results. The system fails.

(2) Event-driven Projects Executing a Calendar-driven Budget. The Planning, Programming, Budgeting and Execution System (PPBES) requires a calendar-driven sequence of events while the DAS follows an event-driven schedule (Jones, McCaffery, & Fierstine, 2005). This means DAS programs must demonstrate increasing maturity and readiness as they approach eventual fielding. These programmatic demonstrations, defined very early in a program's lifecycle, occur as readiness reviews and milestones and require formal approval by the milestone decision authority. As a technologically intensive system proceeds through the DAS, beneficial innovations sometimes allow them to accelerate their schedule and potentially provide a capability to the warfighter sooner than expected. However, the PPBES, inflexibly calendar-driven in nature, does not allow for such change and requires a program to remain on schedule as technological innovations come and go. As Mr. Robert Carey, the Navy's Chief Information Officer (CIO) said in a recent interview,

> Things are moving really fast. The acquisition system, and more importantly the budgeting system, moves at a different pace… Today, if most of you come in and say, 'I've got this great idea. I want to give it to you,' all of our money has been displaced… There

> is little agility in that system. When you go spend it on something else, an opportunity, you generally have to break something else." (Boessenkool, 2009)

More common than an opportunity to accelerate though, is the occurrence of some problem in the process causing a schedule delay or an inability to execute its budget. The PPBES not only discourages such change, it effectively punishes it through a use-it-or-lose-it mentality. In other words, if a program cannot execute funds before they expire, it will probably lose those funds to a program that *can* execute them. As an additional consequence, it will have a much harder time justifying keeping its funds in future years. This inflexibility can have a compounding negative effect of spiraling a program into further delays, which allows mainstream technological capabilities to outrun the program's original requirements until the first bullet above comes to fruition: the need for the project disappears and it ultimately fails to deliver anything of value to the user.

(3) Lack of Personnel Continuity. The USMC has recognized the importance of a qualified acquisition workforce and strives to better support it through the creation of new military occupational specialties (MOS), continuing education, and centers of excellence. These efforts, respectable as they are, do not solve the personnel continuity problem in the acquisition community though. USMC Manpower and Reserve Affairs requires military members to continue duty rotations every three years. If a workforce member arrives at his acquisition command, new to military acquisitions and unfamiliar with its vocabulary, organizations, and requirements, it will take about a year before he or she effectively contributes to a program. During this action-officer learning time a program seldom advances as quickly and effectively as it would with an experienced acquisition professional at the helm. Although hard to justify one person holding an entire program back, when that program encounters personnel changes continuously, negative effects inherently accumulate and the program suffers. Furthermore, considering the slow pace of military acquisitions where three years might encompass only a single phase of a

program's procession through the DAS, the program may potentially have multiple managers and project officers throughout its lifecycle, each of whom requires separate, time-consuming learning curves. Because of this fact, the program's institutional memory and tacit knowledge constantly and quickly fades; lessons learned go undocumented and subsequently require relearning, further challenging any programmatic advancement. This discontinuous knowledge limits a program's progress and schedule delays result, both of which can lead to eventual project failure.

(4) Onerous Documentation, Regulations and Reporting Requirements. Although the DAS encourages streamlining the acquisition process, its efforts fall short of the efficiency and speed necessary to exist as a viable means to procure IT systems. On the surface, the DAS instruction appears to support flexibility, which logically improves the process. But the numerous statutory and regulatory requirements levied upon even small programs render the process anything but easy. The tables in the DoDI 5000.02 reveal the documentation required for a program offering a mature technology to enter the process at, for example, Milestone C (Production and Deployment): 14 different statutory requirements and 26 regulatory requirements… 40 different documents, all of which require review and approval up a hierarchical chain of command. The generation of such a mound of paperwork and its subsequent approval do not happen overnight. In fact, the process takes months or sometimes years. Although the documentation requirements arguably intend to protect the American taxpayer from wasting money on failed acquisition programs, they often have the opposite effect, further delaying an already slow process to a point where the user no longer values the end product.

The four categories above illustrate how a program can fall victim to the numerous time taxes and distracters that delay system delivery to the user. In the information age, the value a warfighter places on a specific solution stales quickly, so any delays in the provision of that solution lead to decreased value and can spell eventual failure for the system and its associated program. Speed increases value; likewise, lateness provides little value. This cause of failure due to a lack of acquisition timeliness defines the second of two broad categories discussed, the first being system-specific causes of failures. One other contributor to DoD IT project failure does not fit neatly into either category, but deserves mentioning here. It relates to the operator's perception of military acquisitions.

Warfighters unfamiliar with the acquisition world typically hold a negative view of DoD acquisitions… and for good reason. They identify operational needs for the acquisitions process and sometimes participate in the formal requirements generation events or user juries. But seldom during their current tour (typically about 3 years) will they actually see a system go from inception to successfully operational, satisfying those needs. This unfortunate fact again occurs due to the typically slow and unresponsive acquisition process. The users maintain sad awareness that, for reasons mostly unknown to them, it takes years to define, develop, test, and deploy a system in the DoD. This awareness combined with the dissatisfaction from inadequate support plans for many existing systems has led to a distrustful attitude on the part of the user community that greatly contributes to prejudices against new systems. Sarcastic phrases such as "drive-by fielding" or "another 'fine' product from Systems Command" evidence this cynicism. Failures of new systems sometimes spiral into self-fulfilling prophesies due to these types of prejudices. The user declares the new system a failure before ever giving it a fair chance at success.

When these perceptions and prejudices apply to an IT-intensive system highly susceptible to technological progression laws such as Moore's, [2] Butter's, [3] and Kryder's,[4] the user's negative view of military acquisitions

[2] Gordon Moore's Law states that the number of components per integrated circuit doubles every 24 months (ComputerHistory.org, 2007).

[3] Gerry Butter's Law states that the amount of data we are able to transmit through an optical medium doubles every 9 months (Robinson, 2000).

entrenches even more firmly. In the deployment phase of the acquisition cycle, the user receives IT systems that often incorporate obsolete technology, usually due solely to the slow speed of the acquisition process. Furthermore, the user has a keen awareness of the system's obsolescence because today's warfighters, as members of the information generation, maintain a solid grasp on the technological trends of the day. They unfortunately judge the performance of military systems against the commercial systems found on the shelves of their local electronics retailer and in such comparisons, the military systems fall short every time. Simply put, the warfighter values the availability of current technology and objects to the provision of old technology. This again illustrates the value of a timely acquisition process.

A better means of acquisition—a more agile, responsive process that focuses on providing incremental value to the user in rapid succession—could greatly lessen the negative impacts of some of these factors contributing to user dissatisfaction and project failure. This holds especially true for IT acquisition projects subjected to both obsolescence and constantly changing targets. Using the previously stated definitions of success and failure, delays greatly exacerbate the impacts of most of the above causal factors and effectively push projects closer to failure. On the other hand, decreasing the so-called time to market followed by rapid, iterative improvements will increase value and, consequently, the program's chances of success. Considering these observations, the acquisitions process in the DoD needs rapid, value-based, evolutionary acquisition.

[4] Mark Kryder's work involves analyzing the impacts of exponentially increasing bit storage capacity relative to physical component size, and he hypothesized that magnetic disk areal storage density doubles annually (Walter, 2005).

# III. RAPID, VALUE-BASED EVOLUTIONARY ACQUISITION[5]

Throughout history, environmental changes have caused adaptive adjustments in the methods and management techniques used by organizations to develop and produce items. Organizations realized a need for improvement and they adjusted their methods accordingly. For example, the increasing complexity of systems along with an expanding environment in the mid-1900s gave rise the discipline of systems engineering (Hall, 1962). Project management illustrates another example of such an adjustment. Although practiced for centuries, its formalization as a discipline did not occur until the 1950s when managers saw a need to approach projects from an integrated perspective, methodically accounting for complexities between cost, schedule and performance of systems (Cleland & Gareis, 2006). Most recently, the past two decades have witnessed a dynamic shift in the commercial sector's ability to produce technologically superior products compared to the military. Historically sought after because of its toughness and rigorous Military Specification (MILSPEC) standards, the equipment of the defense industry previously pioneered technological advancements, and commercial applications of the innovations typically followed. But the market's insatiable demand for the cutting-edge capabilities stimulated a role reversal. Private industry assumed the military's role as technological pioneer, and the latest products, after proven commercially, seek applications in the military (Alberts, Garstka, & Stein, 1999). Furthermore, the military has increasingly less influence on the private sector because of its declining share of the IT market as shown in Figure 2 (Stogdill,

[5] The name, Rapid, Value-based, Evolutionary Acquisition (RVEA), is mostly credited to Chris Gunderson, David Minton and Rick Hayes-Roth from their whitepaper entitled, "Value-Based Acquisition: An Objective, Success-Centric, Evolutionary Approach." Although this approach has other additional attributes, this thesis emphasizes its rapid, value-based, and evolutionary nature as its three most important qualities, and therefore coins the name RVEA.

1999). In a reactionary effort to take advantage of these commercially developed, technologically mature items, the DoD conceived evolutionary acquisition (EA).

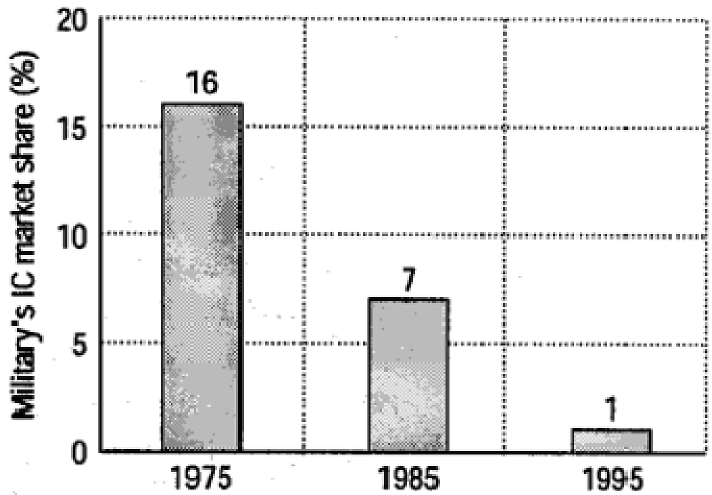


**Figure 2. Military's Integrated Circuit Market Share (From Stogdill)**

EA, *in policy*, proposed an improvement in military acquisition because it allowed development of capabilities in increments, as opposed to forcing the use of the traditional waterfall method. Additionally, the DoD instruction implementing EA declared it as the "preferred" acquisition method and theoretically provided flexibility to procure mature technologies relatively rapidly, instead of requiring full procession through development, engineering, and testing (DoDI 5000.02, 2008). EA looked like, at least *on paper,* a step in the right direction to account for yet another environmental change.

## A. THE REQUIREMENT FOR RVEA

The DoD created EA for relatively simple reasons: react to environmental factors of (1) increasing systems complexity and the related requirement for better planning, and (2) increasing demand for flexibility and rapidity. Certainly, the pressures that spawned systems engineering, project management, and EA as illustrated above pertain today. Continual improvement necessitates further adjustment beyond simple EA in order to optimize our response to these forces.

As mentioned, the DAS prefers EA as its acquisition method in policy, and at first glance considering the enlightening language of some of the acquisition regulations, one might believe EA contains the sought-after improvement sufficient to improve acquisition effectiveness. After all, it sounds good on paper, but according to the GAO, DoD has yet to implement true evolutionary development in practice (GAO-06-110, 2006). The GAO uses the Joint Strike Fighter as an example of a current program attempting to provide too many significant capability improvements in a single step rather than providing incremental improvements in capabilities over time. Such overly ambitious capability leaps inevitably result in schedule delays, neglecting the importance of timeliness (providing value to the user as quickly as possible). Additionally, attempting to provide a 100% solution predictably causes other problems such as cost overruns and considerable interoperability challenges. Although the DoD has recognized the requirement for an evolutionary acquisition method and attempted to implement it in policy, in actuality the process still desperately needs improvement.

Another evolutionary environmental force alive and well today relates to our dependence on IT, and considering the ambitious goals of defense systems now compared to only a few years ago, this dependence will only increase. Combine our escalating dependence with the dismal success rate of information systems projects described in a previous section, and most of the high aspirations for information systems supporting national defense will probably never materialize… unless we find and implement a better means of acquiring those systems.

## B. THE FOUNDATION OF RVEA

National defense today demands harnessing the power of information. Our highest leaders have recognized information’s strategic and tactical importance (DoD Information Management and Information Technology Strategic Plan, 2008-2009) as evident in concepts such as full spectrum dominance, information/net-centric operations and warfare, systems of systems, and the Global Information Grid, to name a few. These concepts aspire to improve decisions largely based on *information*. It therefore makes sense that possessing better information and processing it more effectively and efficiently than the enemy will lead to better, faster decisions, which in turn will produce better outcomes. Joint Publication 3-13 calls this ability Information Superiority: “The operational advantage derived from the ability to collect, process, and disseminate an uninterrupted flow of information while exploiting or denying an adversary’s ability to do the same” (Joint Publication 3-13, 2006).

Militaries cannot accomplish information superiority overnight, nor can they achieve it and then forget about maintaining it. Instead, information superiority embodies a position that our forces must first deliberately attain, and then, just as important and perhaps more difficult, effectively maintain and exploit. Gaining and holding a superior information position requires a highly effective process of continual improvement, staying a step ahead of the enemy by focusing on value and speed… a process in which information systems technology has become a critical enabler.

Coincidentally, the process of achieving information superiority has many noteworthy similarities to the process we should use to develop and procure its supporting technologies and ultimately provide value to the user. Three of these similarities—value-based, rapid, and continual improvement—form the foundation of RVEA and the following sections describe the qualities of this process, pointing out similarities with the process of attaining information superiority.

### 1. Value-based

The book, *Network Centric Warfare*, states that exploitation of a superior information position results in a competitive advantage, which in turn creates information superiority. The book goes on to say that the “creation of value is at the heart of creating [this] competitive advantage.” (Alberts, Garstka, & Stein,

1999) The information collected, communicated and exploited in attaining information superiority therefore requires value. Without value or meaning, information merely contributes to info-glut and clouds situations, increasing the fog of war, which consequently decreases combat effectiveness (Hayes-Roth, Model-based Communication Networks and VIRT: Filtering Information by Value to Improve Collaborative Decision-Making, 2005).

One cannot discuss the concept of information value without also mentioning *how* value is determined, or more appropriately, *who* determines value. Decision-makers and operators define the value of information based upon its ability to contribute to their knowledge of a situation, and their input therefore determines what information to filter or forward. Imperative here is who defines value: not the system developer or administrator of the filter mechanism; instead, the decision maker decides value. Operational commanders as decision-makers practice this concept routinely by defining commander's critical information requirements.

While the process of achieving information superiority relies on the production of valued information, an acquisition process must similarly produce valued operational products. As described in the previous section defining project success and failure, the user of such a product measures value in terms of its ability to improve his or her job, just as the user of information defines its value based upon how it improves their decisions. For this reason, user involvement rises to an essential level in the acquisition process… not only the requirements definition phase, but also the system's development, testing and beyond. Employing users in this manner first ensures value as an objective and second confirms a system's ability to provide that value. Likewise, neglecting user input at these critical points will lead to the developer assuming what defines user value, and the system will likely miss the mark, which will certainly contribute to the project's ultimate demise.

### 2. Rapid

The pace of life continues to accelerate. Each decade, the speed required for achieving success markedly increases. Society demands swiftness for the reporting of news, weather, market quotes and other types of information because the value of that information decreases over time. We, as members of society, also require the ability to instantly and remotely communicate with each other, and technology allows us to do so through email, text/instant messaging, etc. The relatively high speed these capabilities offer assists in making us more knowledgeable and efficient than without them.

Warfare also moves at a more rapid pace today than in previous decades, and combatants sometimes win battles because of an ability to achieve and exploit a superior information position partially due to rapidity. Capitalizing on a superior information position requires timeliness or speed for two reasons. First, we must collect, analyze, act upon information, and then repeat the process more quickly than the enemy can. Boyd called this "getting inside the adversary's OODA loop." (Boyd, 1986) Originally applying this concept to air combat maneuvering (ACM) in the Korean War, he won visual aerial combat engagements, or dogfights, by observing, orienting, deciding and acting (completing the OODA loop) repetitively faster than his opponent could. This technique eventually placed him in an advantageous position that he capitalized on in the form of weapons employment. Boyd captured this technique in his writings as a military strategist and it has since seen application to larger-scale competitions, including gaining a strategic advantage in modern conflicts such as Operation Desert Storm in 1991 (Cowan, 2000). Possessing a faster decision cycle contributes to one's ability to achieve and exploit information superiority.

The second reason speed matters greatly for information superiority derives from the perishability of information. The longer information sits unattended, the staler it becomes. In war, this fact results primarily from the fast rate of change of the battlespace. Operational forces have the same demands as society for current—as close to real time as possible—information because it quickly stales, especially in wartime. Old information often equates to inaccurate information due to an unobserved change in the situation, and it seldom produces optimal decisions because of this inherent inaccuracy. In fact, *no* information is usually better than *inaccurate* information because, lacking information concerning a situation, commanders will make typically conservative estimates, fully realizing they cannot accurately grasp the situation's reality. Whereas unknowingly using inaccurate or stale information gives rise to suboptimal or even wrong decisions. Commanders therefore, just like society, require *current* information in order to increase their knowledge and efficiency, effectively improving the quality of their decisions in pursuit of information superiority. Rapid observation and analysis of a situation followed by quick decisions and actions form key enablers of this ability. Bottom line: speed increases value.

Speed also translates into increased value in the acquisition process for reasons similar to those above in attaining information superiority. The ability to observe, orient, decide and act more quickly than our opponent allows us to get inside his loop and achieve a competitive advantage. Likewise, we must get inside the loop of our opponent in the acquisition process, but on the acquisitions battlefield the enemy lurks as both external and internal forces. Externally, the current enemy is the same as in the Global War on Terror, a wily and quickly adaptive adversary not bound by acquisition rules and regulations or even the Geneva Conventions. His weapons include IEDs and suicide bombers, and only their imagination and budget limit their capabilities. Internally however, the enemy resides within a slow acquisition process which cannot cope with a rapidly changing environment, and it wields weapons of technology obsolescence and changing requirements.

Focusing on the internal enemy, the acquisition cycle time, or loop, must operate faster than the forces of obsolescence and requirements change, both of which devalue a system in the eyes of an operator, just as time decays and devalues information supporting an operational commander. To quantify this concept, obsolescence occurs constantly, but in general, commercially available technology's planned lifecycles survive only about 18-24 months, paralleling Moore's Law (Beck, 2003). Requirements changes follow a similar, albeit less predictable pattern, influenced by factors such as the global security environment, adversary's capabilities, and technological advancements. RVEA should therefore strive to provide an operational capability within no more than 2 years after deciding upon a particular technology. The risk of not doing so could easily result in fielding an obsolete or unnecessary system.

Denning, Gunderson and Hayes-Roth articulate the significance of a short acquisition cycle time:

> Development time is the critical factor. This is the time to deliver a system that meets the requirements set at the beginning of the development process. If development time is shorter than the environment change time, the delivered system is likely to satisfy its customers. If, however, the development time is long compared to the environment change time, the delivered system becomes obsolete, and perhaps unusable, before it is finished. In government and large organizations, the bureaucratic acquisition process for large systems can often take a decade or more, whereas the using environments often change significantly in as little as 18 months (Moore's Law). (Denning, Gunderson, & Hayes-Roth, 2008)

Figure 3 illustrates this problem by depicting a desired increase in capability over a few years. A system using a single step approach (top graph) or even a lengthy incremental evolutionary approach (middle graph) risks missing the target primarily because of the prolonged time to value. The question marks on the graphs indicate the uncertainty involved in aiming at a distant, randomly moving target. The long-term requirements freeze many years before planned delivery. This early target determination occurs too prematurely to estimate (1) exactly how requirements will change or (2) what new technological innovations will arise over the course of those years, either of which stand to lessen the value of or even nullify the system in the operator's opinion. The bottom graph depicts the alternative, which provides value to the user in much shorter increments than the middle graph, and then repeats, effectively allowing continual retargeting, as opposed to risking missing a long-range, potentially infeasible target defined years earlier.[6]

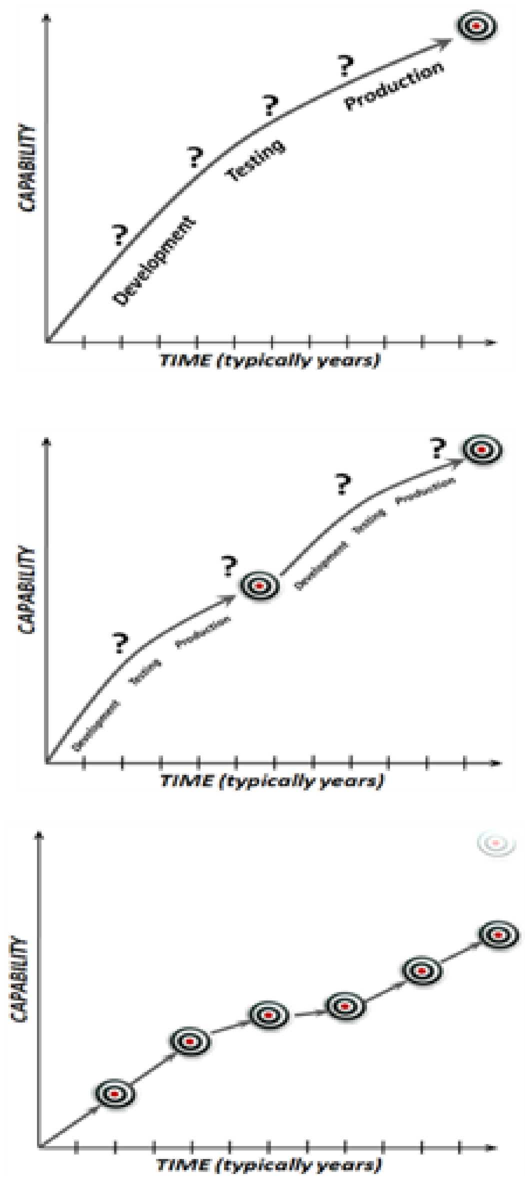


**Figure 3. Desired Capability vs. Time. The progression of charts from top to bottom illustrate different approaches to managing acquisition, ranging from a "ballistic" attempt to deliver desired capability in a single cycle to a rapid adaptive approach with multiple short cycles**

[6] The graphs in Figure 3. are adapted from a classroom discussion from Dr. Hayes-Roth's *Information Systems Strategy and Policy* at the Naval Postgraduate School.

**continually re-aimed toward the next target of incrementally improved capability. (From Hayes-Roth)**

Expanding on Boyd's ACM analogy, the tactical aircraft saying, "Speed is life!" further illustrates the value of rapidity. Fighters require high maneuverability, and lacking sufficient speed, they cannot maneuver to attack or defend. In aerial combat, bleeding airspeed is relatively easy, but opportunities to gain airspeed in the visual arena seldom occur. For this reason, possession of a speed or energy advantage creates a competitive advantage over the enemy.[7] Alternatively, in a visual air-to-air engagement if a fighter pilot finds himself excessively slow against an opponent who has and maintains an energy advantage, the opponent will eventually gain an offensive position because of his superior maneuverability and kill him. In an air-to-ground mission requiring reaction to enemy air defenses, speed is essential for the same reason; a lack of speed effectively makes an aircraft unable to defend against surface-to-air fires. Similarly, we can usually slow down an acquisition process, but seldom can we speed it up once started. Additionally, if we do not maintain the speed of an acquisition process, producing valued systems inside our adversaries' loops, they—the enemies of obsolescence or requirements change—will render our product value-less and the program will eventually fail.

Continuing the aerial combat analogy, as an additional benefit, speed increases options. With a sufficient speed advantage, a fighter aircraft has multiple options from which to choose that translate into a competitive advantage, such as exchanging knots for nose position to employ weapons or converting excess kinetic energy into potential energy by climbing to establish an altitude sanctuary from which to attack or escape an opponent. In contrast, with a speed disadvantage an aircraft really has only one option: try to increase

[7] This logic purposefully over-simplifies the value of high speed in an ACM engagement. The author recognizes the significance of cornering speed and the fact that an offensive aircraft can easily be "too fast" in some situations such an impending overshoot. The author also recognizes the value in other situations of slow speeds, such as when attempting to force an opponent's overshoot.

kinetic energy by descending while also trying to stay alive. Similarly, the quicker we provide a valued capability to the user, the more rapidly we can analyze our new situation relative to the enemy (including technological opportunities and operational requirements), capitalize on any successes, and apply them to our future objectives, effectively shortening our cycle time while providing more options. Alternatively, a prolonged acquisition process only has one option: continue towards long term and perhaps outdated requirements or face termination.

Accomplishing our objectives requires a rapid process, whether in pursuit of information superiority, in a dogfight, or in acquisitions. Intuitively, possession of a faster process than the enemy directly contributes to successful operations and consistently provides more options from which to choose. Again, the bottom line: Speed increases value.

### 3. Continual Improvement

Achieving a competitive advantage necessitates continual improvement, and once we achieve it, sustaining that position requires the same consistent focus on continual improvement. In an effort to accomplish this, military Services use feedback mechanisms to improve upon past military operations in the form of lessons learned, after action reports, case studies, and general military history. We teach and study such documentation in an effort to retain and convey our predecessor's knowledge. For example, the Marine Corps has recognized the value of a feedback mechanism through the creation and staffing of its Center for Lessons Learned, which strives to capture operational experiences in an effort to improve future operations and exercises.

Achieving information superiority also requires a feedback mechanism to support continual improvement. This mechanism involves validation of multiple facets of information in order to realign future actions toward an end goal. This process requires an established methodology to capture and analyze not only previous actions taken, but also the effects resulting from those actions. In his book, *Hyper-Beings*, Dr. Hayes-Roth emphasized the importance of an effective feedback mechanism to enable adaptive behavior and facilitate improvement (Hayes-Roth, 2006). Referencing Figure 4, the last step of his eight-step superior decision loop is *Validate and Improve the Model*. Although the model defines it as the last step, it occurs not only at step eight, but throughout all steps of the loop, which forms the essence of *continual* improvement. Applying his model to the achievement of information superiority, while focusing on step 8, we see that we must continually validate and improve upon the following facets of information:

- Which information provides value
- How we get that information
- How we analyze it
- How we use it to change our behavior
- How we communicate it

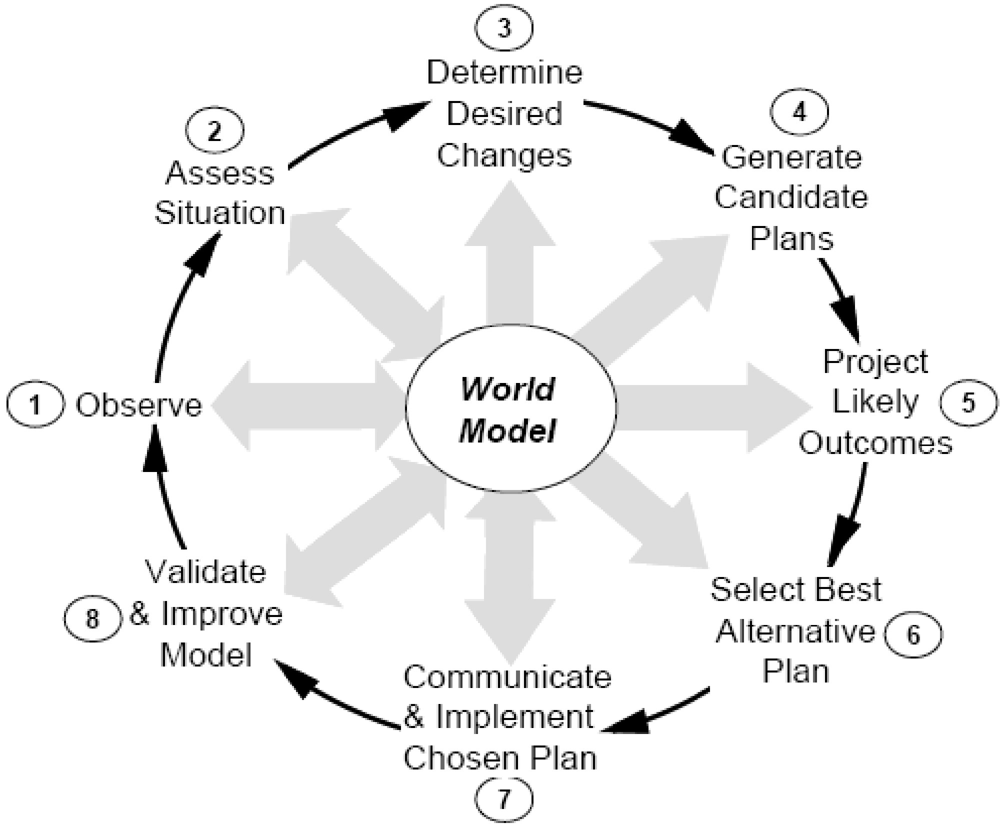


**Figure 4. The Superior Decision Loop (From Hayes-Roth)**

RVEA must similarly incorporate continual improvement. EA, although an acquisition policy improvement as defined in the DoD Instruction 5000, does not effectively incorporate feedback or focus on continual improvement. To its credit, it mentions spiral development in which we develop a little, test a little, develop a little more, test a little more, but it does not stress the importance of establishing a methodology to improve upon each spiral over time. EA, as opposed to RVEA, does not necessarily capitalize on what works and kill what does not. Instead, it takes the results of a spiral – whether successful or not – and attempts to fix it or add functionality to it, inevitably increasing its complexity and consequently decreasing its evolvability (Sangwan, Lin, & Neill, 2008). In order to keep this complexity in check and continue focusing on valued improvements, a program office cannot allow a casual validation and improvement process; on the contrary, it must ensure a documented, formal methodology.

Additionally, EA prematurely plans increments and spirals in a system's lifecycle. For instance, it illustrates a version of so-called continual improvement that shows three planned increments over fifteen years with preplanned product improvements every five years. This is too scripted and inflexible! A program office must incorporate a more responsive process that captures dynamic, constantly moving targets and quickly provides multiple options from which to choose, implement, and improve on.

Furthermore, lacking such a process that incorporates continual improvement will, sooner or later (probably sooner), decrease the value of even the most valued system because of the rate of change of requirements and technology. In other words, as the operators increasingly value, or perhaps more appropriately, *covet* systems they do not have, their current system's relative value decreases… unless we continually validate and improve upon the current system. As mentioned earlier, users value current technology and object to old technology.

Similar to the process of attaining information superiority, an acquisition process that incorporates continual improvement must strive to validate and improve different aspects of the process as well as the product. Unfortunately, the DAS encompasses multiple levels of a large hierarchical organization and one cannot overstate its complexity. As Dr. Hayes-Roth points out though,

> Regardless of how many levels of hierarchy, all intelligent entities operating in dynamic environments have to adapt their behavior continuously in response to feedback. The entity as a whole uses a decision loop to do this, and each subordinate entity in the hierarchy uses a decision loop in its own area of responsibility. (Hayes-Roth, 2006)

The entities could be as large as our National Command Authority (NCA) that sets vision and strategy, or as small as an acquisition program office charged with implementing an acquisition plan. Improving the acquisition process as it relates to the NCA is not the purpose of this thesis, so narrowing the broad scope of potential areas for continual improvement, subordinate entities such as the program office and program manager must continually validate and improve the following items to effect continual improvement:

- What acquisition items provide value
- How we develop and procure them
- How well we are progressing toward providing value
- How we should change our behavior to improve value delivery

Notice the emphasis on value in the above list as a focal point for continual improvement. Once we implement a process based on value, we will become engaged in a process of continuous improvement (Hayes-Roth, Blais, Pullen, & Brutzman, 2008).

Sometimes our validation and feedback process may reveal a need for a significant direction change. We cannot fear such change and we must address it forthrightly. For example, an environmental change may completely invalidate a requirement for a system, and the program may require termination. In order to effectively implement continual improvement, the acquisition process cannot shy away from such change or fear writing off sunk costs. It benefits all stakeholders to stop development of an unwarranted system instead of continuing to mount expenses through the unnecessary production, fielding and support of such a system. According to the GAO, sunk costs should not drive the decision to continue a program (GAO-08-379, 2008). Continual improvement means making occasionally tough but intelligent decisions. Although these decisions may sometimes displease certain stakeholders, an effective acquisition process hinges on them to a large degree.

Finally, two caveats relating to continual improvement deserve attention. First, an effective process of continual improvement does not warrant setting unjustified or haphazard strategic targets simply because of the ability to improve upon them later. Initial goal setting requires deliberately calculated, insightfully visionary, and ambitious but feasible targets. An organization cannot overemphasize the importance of this step. The existence of an effective feedback loop and improvement method should not serve as an insurance policy or safety net for bad strategic decisions. Second, continual improvement does not mean continual change. An organization with an effective method of accomplishing continual improvement should not consequently encourage continual change. On the contrary, an effectively planned vision, strategy and policy should minimize the frequency of major changes… even in the name of continual improvement.

To summarize, rapid, value-based, evolutionary acquisition's foundation rests on the principle of quickly providing user-defined value in rapid succession while focusing on continual improvement. These three traits—rapid, value-based, and continual improvement—form the basis of an effective acquisition process. The actual implementation of RVEA includes the same phases as contained in the DoD's instruction for the operation of the DAS and aligns with that regulatory document. The next section details the specific actions and intents of RVEA throughout each DAS phase.

## C. THE OPERATION OF RVEA

With the firm establishment of a conceptual foundation of rapid, value-based evolutionary acquisition, this section will concentrate on its tangible application. It strives to avoid abstractions, difficult to implement in the real world of acquisitions, and instead focuses on pragmatic, readily executable recommendations for a Program Management Office (PMO) or Program Executive Office action officer… where the proverbial rubber meets the road.

### 1. Introduction

This section briefly describes the underlying assumptions and constraints of the application of RVEA. Additionally, it includes descriptions of the most applicable documents that govern the defense information systems acquisition process.

#### *a. Assumptions and Constraints*

Government policies and regulations naturally resist change. Even if an established rule obviously and admittedly needs change, rescinding or modifying it presents quite a challenge. For example, the DoDI 5000 took years to update, and when the Defense Department finally published the revision in December 2008, it included surprisingly minimal changes, considering the time required for revision. This thesis therefore does not suggest improving the acquisition process through changes in acquisition policy. Such change would take too long, and whether the regulations need major revision is actually debatable. The process needs help now, and any improvement must operate under the constraints of all currently applicable regulations, directives, and instructions.

The prescription to heal the problems with the DAS implies widespread cultural change, but one cannot realistically believe any single person or organization could implement a DoD-wide or even Service-wide culture shift with the urgency required. The culture of government and DoD acquisitions, deeply rooted in stove-piped, *I've-got-mine* mentalities and self-promoting, *get-your-own* rice-bowls, will not change overnight. However, breaking these bad habits and the desired broad cultural change begins with individuals and their successes, which eventually spread throughout organizations, resulting in the desired change. This change can and must begin with the individual action officers of acquisition programs. In the words of Gandhi, "You must be the change you wish to see in the world."

### *b. Governing Documents*

The phrase “governing documents” encompasses numerous statutory and regulatory items which control the DoD acquisition process. Some of these items include Instructions and Directions, the Federal Acquisition Regulation (FAR), and various laws such as the Information Technology Management Reform Act of 1996 (aka the Clinger-Cohen Act or CCA). These documents define the rules of the acquisition process. The subsections below briefly describe some of the Defense acquisition’s primary governing documents for information systems in order to first provide the reader an appreciation for the rules under which acquisition action officers must operate, and second to point out some of the encouraging, positive aspects of these documents. Additionally, the description of the DoDI 5000.02 will lay a framework for the subsequent discussion of the application of RVEA.

(1) DoDI 5000.02 - Operation of the Defense Acquisition System. The DoDI 5000.02 establishes

> a simplified and flexible management framework for translating capability needs and technology opportunities, based on approved capability needs, into stable, affordable, and well-managed acquisition programs. (DoDI 5000.02, 2008)

The document’s basis lies in governance-by-exception where, unless specifically prohibited, an action is allowed as long as it proves itself appropriate, justified and does not violate another regulation. This encourages innovation and attempts to avoid stifling so-called thinking out of the box. The instruction discourages the application of additional restrictions from the DoD Services and Components and allows waivers to its guidelines unless prohibited by statute. It provides lists of all statutory and regulatory requirements for the lifecycle of an acquisition program, and contains sections which describe Acquisition Categories and determination of Milestone Decision Authority, IT considerations, Systems Engineering, Resource Estimation, as well as other subjects directly pertaining to defense acquisitions.

The first part of the instruction, divided into applicable sections, details the procedures of the phases of the acquisition process as depicted in Figure 5. Material Solution Analysis (aka Pre-Milestone A), Technology Development, Engineering and Manufacturing Development (EMD), Production and Deployment, and Operations and Support comprise the phases of defense acquisition and typically describe the life-cycle phase of a program. Notice, however, the three broad phases in the lower portion of the diagram: Pre-System Acquisition, System Acquisition, and Sustainment. These will serve as categories for the application of RVEA in subsequent sections.

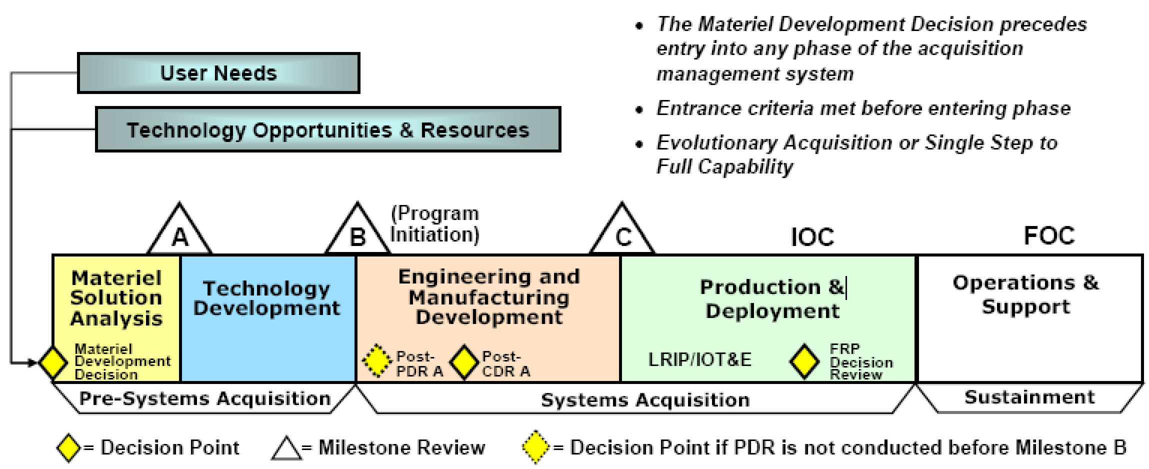


**Figure 5. The Defense Acquisition Management System (From DoDI 5000.02)**

(2) Federal Acquisition Regulations System. The government established the Federal Acquisition Regulations System for the codification and publication of uniform policies and procedures for acquisition by all executive agencies of the U.S. Government, and the FAR is the primary document of the system. An enormous document with Volume 1 stretching to almost 2,000 pages, the FAR, not unlike the DoDI 5000.02, takes a govern-by-exception approach. It provides regulatory guidance for the purchase of products and services, and most of its parts contain at least some applicability to systems

acquisitions. In the context of this thesis however, only certain parts of the FAR will be mentioned, particularly Parts 1, 7, 12, 13, 34, and 39. The paragraphs below paraphrase these specific FAR parts relevant to this thesis (Federal Acquisition Regulation, 2005). Notice the bold italicized words (formatting added for emphasis).

- Part 1 - Federal Acquisition Regulations System. If a particular strategy or practice is neither specifically addressed in the FAR nor prohibited by law members should not assume it is prohibited. Rather, teams should interpret absence of direction as permitting ***innovation***.

- Part 7 - Acquisition Planning. Agencies shall perform acquisition planning and conduct market research for all acquisitions in order to promote and provide for acquisition of ***commercial items*** and for full and open competition to the maximum extent practicable.

- Part 12 - Acquisition of Commercial Items. Agencies ***shall acquire commercial items or nondevelopmental items*** if available to meet the needs of the agency.

- Part 13 - Simplified Acquisition Procedures. Prescribes simplified acquisition procedures in order to reduce administrative costs, ***promote efficiency and economy*** in contracting, and ***avoid unnecessary burdens*** for agencies and contractors.

- Part 34 - Major Systems Acquisition. Ensures agencies acquire major systems in ***the most effective, economical, and timely manner***. Agencies acquiring major systems shall promote ***innovation*** and full and open competition and sustain effective competition between alternative system concepts and sources for as long as it remains beneficial.

- Part 39 - Acquisition of Information Technology. When developing an acquisition strategy, ***contracting officers should consider the rapidly changing nature of information technology*** through market research and the application of technology refreshment techniques. (Note that as National

Security Systems, most DoD systems would fall under Title 40 United States Code, Section 11302, instead of the FAR Part 39.)

Considering the phrases emphasized above, the FAR means well and encourages innovation, efficiency, and rapidity. RVEA embraces these characteristics and brings them to the forefront of acquisition as measurable qualities.

(3) Clinger-Cohen Act. The CCA mandated the establishment of goals for improving the efficiency and effectiveness of agency operations through the effective use of IT. Additionally, the CCA sought to prescribe performance measurements for executive agency IT and ensure these performance measurements determine how well the IT supports agency programs (The National Defense Authorization Act, 1996).

Having briefly described some of the documents governing the acquisition process, the next section will prescribe recommended improvements for the process using RVEA within the bounds of these documents.

## 2. Operation of RVEA

Although the DoDI 5000.02 defines the commonly referred to phases of the acquisition process from Pre-Milestone A to Operations and Support, this section employs the broader activity phases of Pre-System Acquisition, System Acquisition, and Sustainment to describe the specifics of RVEA.

### *a. Pre-System Acquisition*

Many tasks and activities must be accomplished prior to the start of a new acquisition program of record, and many do not directly involve acquisition action officers, *per se*, because of the top-down nature of the requirements generation system called JCIDS (reference Figure 6 below). Through the JCIDS process, top-level military officers of the Joint Requirements Oversight Council (JROC) identify capabilities required to support national strategies such as the

National Defense and National Military Strategies. Specifically, the JROC identifies (1) the capabilities and operational performance criteria required to execute missions successfully; (2) the shortfalls in existing systems to deliver those capabilities and the associated operational risks; and (3) the possible solution space for the capability shortfalls. This process supports acquisition by providing validated capability needs and associated performance criteria as a basis for acquiring the right systems, and it provides prioritization and affordability advice (CJCSI 3170.01F, 2007). For the purposes of this discussion on Pre-System Acquisition, we will assume the JCIDS process has first determined a valid requirement for a materiel solution to fill a capability gap, and second, has ruled out all non-materiel solutions.

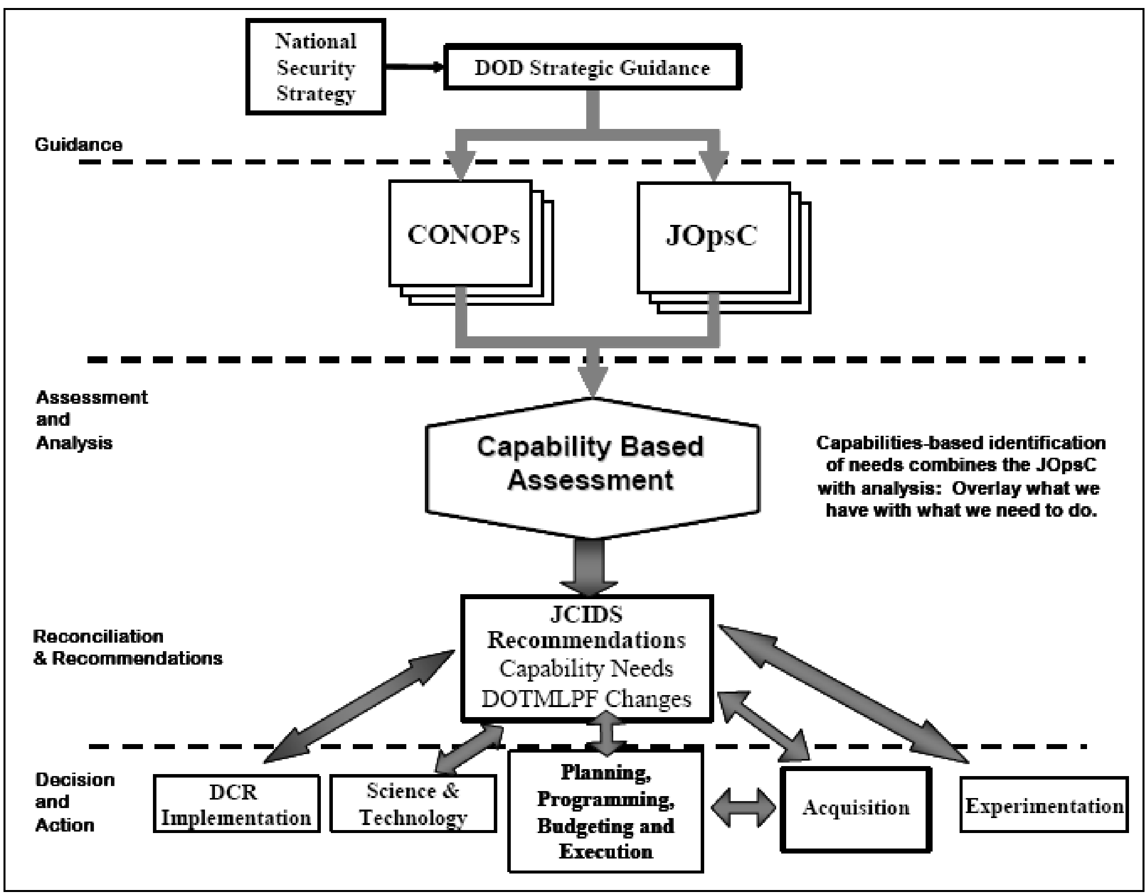


**Figure 6. High-level View of JCIDS (From CJCSI 3170.01F)**

Because of the long-range nature of national strategies, the capabilities and technologies required to achieve these distant targets similarly only exist in the distant future. Reflecting back on the discussion of setting near-term goals for capability improvement (Figure 3. ), a program should hit the target, or achieve the desired capability within two years if at all possible. This does not suggest the JCIDS process should stop identifying long-range strategic capability gaps using its top-down requirements generation. On the contrary, a coordinated and integrated effort across the DoD necessitates the top-down process in its support of national strategy. But once a capability gap and an appropriate materiel solution are identified, the assigned program manager should develop an acquisition strategy that strives to satisfy the most valued portions of the requirement in rapid, short incremental improvements as opposed to attempting to fill 100% of the gap through a prolonged development phase. Case in point: the Joint Strike Fighter (GAO-06-110, 2006). Instead of trying to provide a new airframe with all new capabilities and improvements across multiple venues, it should have focused on providing the most valuable, most needed capabilities first. In other words, if the highest priority capability hypothetically focused on a stealthy airframe to replace the aging F/A-18, AV-8B, and F-16 aircraft, then to the maximum extent possible, it should have concentrated on providing just the airframe as quickly as possible while reusing preexisting, non-developmental items to accomplish other functions as long as it remained beneficial to do so. If at the time, opportunities existed to grab other low-hanging fruit (mature, demonstrated and affordable technology improvements) such as a more capable radar, targeting system, or data link, then by all means, the program rightfully should include those upgraded components in the first increment with the new airframe. But if those items forced delivery delays of the highest priority capability, i.e., the airframe, the program office should have pushed them to future increments. This would assist in fulfilling the requirement for *rapid* delivery of a high-value capability improvement.

If a technology falls short in availability or maturity which consequently prohibits its use to fill a valid requirement, the science and technology (S&T) field should justifiably assume the responsibility of developing and maturing that technology. It should *not* transition to an acquisition program of record (again reference Figure 6. above). Furthermore, development of any immature technologies by S&T should take an evolutionary, survival of the fittest approach to determine successes. Preferably using commercial-off-the-shelf (COTS) technology, this approach should investigate as many parallel competing alternatives as possible to satisfy the requirement and quickly determine which ones succeed and which ones fail. The process should then capitalize on the successful options and continue the cycle, modeling the technology's development after the previously discussed Superior Decision Loop in order to provide continual improvement to not only the product, but also the process. (Acquisition programs of record cannot accommodate this type of developmental approach which investigates multiple options at a rapid rate because of the fiscal and programmatic constraints under which they operate.) Once a technology demonstrates military utility and an ability to satisfy a valid operational requirement in S&T though, it should quickly transition to an acquisition program office to confirm and/or improve upon its operational suitability and to develop production plans. Indeed, the Pre-System Acquisition efforts of an acquisition program office should focus on ensuring the suitability of *readily available, demonstrated* technologies for military use and move away from prolonged development of transformational or revolutionary products which attempt major capability leaps. This will keep programs from experiencing predictable delays of unpredictable duration.

In the Pre-System Acquisition phase, following identification of a requirement for a materiel solution to fill a capability gap, activities must involve the end user in order to help guarantee the value basis of the acquisition. As described previously, the user stakeholder defines the value that helps ensure program success. The activities of this phase requiring user involvement include program reviews such as the System Requirements Review which succinctly define the operational requirements, including Key Performance Parameters (KPP), Key System Attributes (KSA), and system specifications, among others.

Excellent acquisition action officers prove their worth at these program meetings because when user representatives help define a system's requirements, they often neglect to specify things they consider common sense due to a culture barrier between them and the developers. For instance, reflecting back on TLDHS, the users who helped define the initial operational requirements for the system may have never thought they had to explicitly specify the system's usability in direct sunlight, and the early developers could have easily neglected to test the beta system anywhere except in sterile conditions. An acquisition action officer must anticipate challenges such as these and bridge the culture gap between the system designers/engineers and the users to ensure that all significant assumptions become explicit and no requirement stones remain unturned.

Additionally, operators and developers of a system do not necessarily speak the same language (figuratively speaking) and an action officer must sometimes serve as an interpreter in defining and prioritizing a system's quality aspects—usability, reliability, availability, maintainability, transportability, etc. Using a clearly defined and prioritized list of quality attributes based upon user inputs and understood by managers and developers, these three different stakeholders can identify tradeoff points and select the system functions providing the biggest bang for the buck. This prioritized list of functions and attributes will serve as a basis for the program's plan for incremental improvements. User involvement helps ensure the value-basis of a system, and proactive acquisition action officers augment the meaningfulness, clarity, and thoroughness of the user's inputs and help prioritize among many potential valued features.

The responsibilities of an acquisition action officer do not end there. He or she must define a means to measure the above qualities of the acquisition process, because, in the words of Drucker, you get what you measure (Drucker, 2001). Measures of effectiveness (MOEs) have historically seen use as performance metrics of systems or products, but in RVEA, program offices must measure not only aspects of the product, but also the acquisition process itself. Some attributes of the process such as time to value (rapidity) are relatively straightforward to measure. Others, such as value and continual improvement, are more abstract and potentially subjective and therefore benefit from managerial insight and expertise.

Arguably, the value of the acquisition process directly relates to the user-defined value of the end product. An action officer has the means at his or her disposal to measure product value. The simplest of these merely tests the ability of the system to meet the defined operational requirements, usually in the form of KPPs and KSAs. Assuming the validity and currency of the system's requirements, developmental test and evaluation and operational test and evaluation (OT&E) measure a system's performance in terms of reliability, maintainability, speed, and so forth. They consequently also measure the value of the acquisition process to a limited extent. An action officer should not, however, blindly assume the currency and validity of the system's requirements. He or she should formally and informally survey user representatives throughout the acquisition phases to reaffirm the value of the product and process. A formal survey should allow the user representatives to quantifiably answer (for instance, on a scale of 1 to 10) questions such as:

- If the system meets all operational requirements, what is the likelihood you would use it for its intended mission?
- How many alternatives can you think of for accomplishing the system's mission? How many of those alternatives would you more likely use instead of the system?

- How adequate do you consider the planned delivery timeline?
- How much value do you think the planned follow on system increment(s) will add?

Such formal surveys can succumb to the dangers of subjective biases and preconceived notions from the users though. Therefore, in order to qualify survey results, informal, non-retribution discussions between the users and the action officers about the system and its capabilities should supplement formal surveys. To narrow the culture gap and assist in cross pollination between developers and users, open discussions, preferably between these uniformed military members (users and action officers), will help determine the reliability of formal surveys. Such discussions will capitalize on an unspoken trust between uniformed members and help circumvent the military's unfortunate but often present distrust of contractors. Additionally, an acquisition action officer should poll as many user representatives as possible to increase the reliability of such surveys. Although these surveys will not necessarily pinpoint problems in specific system requirements, they will give a program office an overall idea of the value the operators place on the system. Surveys that reveal a widespread lack of user value for a product highlight problems for not only the system under development, but also the potentially broken process as well.

Surveys can help subjectively measure the performance of the acquisition process, but program offices should strive to take a more objective approach as well. Objectively measuring an acquisition process's ability to provide continual, valued improvement does not occur easily, but Chris Gunderson and others at the World Wide Consortium for the Grid (W2COG) have taken a systematic, objective approach and devised algorithms for measuring not only the value basis of an acquisition process, but also its ability to provide continual improvement. Similar to the way the KPP of Operational Availability ($A_o$) measures reliability or Quality of Service (QoS) by dividing successful operating time by total time to give a percent value,[8] their first algorithm conceptually compares the amount of valued information delivered by the system and available to its users against the amount of total information delivered or processed (reference Table 1. below). This formula equates to Information Value Availability, or $A_{iv}$, a system-level MOE, and measures Value of Service (VoS) in terms of the information a system delivers/processes. The next algorithm factors time into the equation by determining Net-Ready Availability ($A_{nr}$). $A_{nr}$, a process-level metric, measures Value of Enhancement (VoE) by calculating how well the process continually delivers valued enhancements to the system, taking into account the process's originally estimated and current build-time performance.[9] In summary, these metrics effectively and objectively measure how much value each increment adds to the process (Gunderson, Minton, & Hayes-Roth, 2009).

| | |
|---|---|
| System Reliability | $A_o$ = Successful operating time / Total time |
| Value of Service | $A_{iv}$ = Available valued bits / Total bits processed |
| Value of Enhancement | $A_{nr} = \dfrac{\text{Initial estimated development time}}{\text{Capability deployment time}}$ |

**Table 1. Conceptual Reliability, VoS, and VoE Algorithms**

The numerous Pre-System Acquisition activities lay the framework for a program's future and, if accomplished in a manner consistent with the principles of RVEA, they can increase the probability of a program's success. The processes of this phase, including but not limited to requirements generation, technology development and establishment of an acquisition strategy, must focus on rapidity, stand on user-defined value, and ensure

[8] This admittedly oversimplifies the operational availability algorithm and the author recognizes that Ao employs Mean Time Between Failure (MTBF), Mean Time to Repair (MTTR), and Mean Logistics Delay Time (MLDT), such that: Ao = MTBF/(MTBF+MTTR+MLDT).

[9] Gunderson, *et al.,* have done extensively detailed analysis to capture the value-added performance of the acquisition process objectively in terms of time-to-capability and value of service, and the algorithms described here are purposefully kept at a conceptual level. As of this writing, their analysis was still ongoing, and this conceptual description is only a sampling of their efforts but sufficient for the purposes of this thesis.

continual improvement. Furthermore, these qualities must translate into measurable quantities that provide meaning to an acquisition program office. Successfully accomplishing these objectives in a program's infancy will help ensure continued success in subsequent acquisition phases.

#### *b. System Acquisition*

System Acquisition technically begins with a program's approval of Milestone B and its subsequent entrance into the EMD phase (reference Figure 5 above). The DoDI 5000.02 emphasizes the importance of demonstrating a potential solution's critical technical elements (CTEs) in a relevant environment before considering the solution a viable alternative. It further states that a technology's maturity shall determine the path through EMD (DoDI 5000.02, 2008). Within this statement lies a program's ability to accomplish rapid acquisition of a capability and quickly provide value to the user: "…a technology's demonstration in a relevant environment and its level of maturity..."

An acquisition program's ability to complete the EMD phase rapidly depends on the level of readiness or maturity of the proposed technology. Given a demonstrated, proven technology, the primary engineering effort of this phase should be limited to systems integration, including bundling of capabilities and functions, and production or manufacturing preparation. Unfortunately, many programs successfully meet the exit criteria of the Pre-System Acquisition Technology Development phase while still immature, with major engineering and development efforts remaining. But how is this possible considering the criteria to exit the phase and enter EMD, which state that, among other things, a potential solution must demonstrate its technology in a relevant environment? Similar to the aforementioned GAO findings of optimistic cost and schedule estimates leading to problems, acquisition programs and commercial vendors can take the optimistic route and purposefully decrease the rigor of demonstrations or the relevancy of the environment in order to "pass" Technology Development and enter EMD. This has the effect of making the technology appear more mature than it actually is – a fact that sometimes materializes months or years later when schedules have slipped and cost estimates have escalated. To avoid this predicament of getting bogged down in EMD, the acquisition action officer must remain true to the warfighter and require rigorous and valid early demonstrations of the CTEs. Relevant demonstrations not only help expedite completion of EMD, but they also can factor into MOEs that will help a PMO objectively determine a system's ability to provide value.

Excessive optimism and subjective measurements of a technology's maturity can ultimately lead to schedule delays, whereas stressing valid technological maturity has the potential to increase acquisition's speed and success rate. Objective MOEs again come into play here as a system proceeds through the EMD phase in preparation for eventual operational testing, production and deployment. Applying algorithms such as those for VoS and VoE above will help enable a program office to measure the maturity and value of a technology as it attempts transition from Pre-System Acquisition to System Acquisition. Furthermore, to maintain awareness of the validity of the product and the effectiveness of the process, a program office should routinely apply the algorithms until its official requirements document formally adopts them as part of a system's KPPs or KSAs.

A program typically completes its Preliminary Design Review (PDR) and Critical Design Review (CDR) in the System Acquisition phase (although sometimes it may complete PDR in the Pre-System Acquisition phase), and emphasis on these reviews has increased in the latest update to the DoDI 5000.02. Such reviews formally establish and confirm a system's underlying architecture. Correctly designed, the system architecture should promote continual improvement through an evolvable, flexible and open framework that will readily accept rapidly changing components. Additionally, the architecture framework should shy away from proprietary capabilities and components and instead concentrate on commonality, which will encourage reusability and agility. These features will pay dividends when developing the manufacturing process, when requirements change, and when future increments take shape. Furthermore, they promote continual improvement and should be built into a system from day one, upon initial architecture definition. Assuming a program has intelligently designed its system architecture which is formalized at PDR and confirmed at CDR, it should possess an inherent ability to continually improve upon the product.

The PDR and CDR also can help a program sustain its value basis. Similar to the activities of requirements definition and Pre-System Acquisition, the source of this value stems not surprisingly from user involvement. The DoDI 5000.02 calls for the presence of user representatives at the PDR, but does not explicitly require their involvement at the CDR. Programs can and occasionally do get side-tracked in development between PDR and CDR and as a result sometimes seem to confuse system priorities, which is another reason an acquisition action officer should never blindly assume the currency or validity of a system's requirements. He or she should constantly strive to gather user inputs at not only these formal reviews, but also user events such as OT&E and Live Fire Test and Evaluation. User input is essential at PDR, CDR and throughout the System Acquisition phase and into the Sustainment phase. The acquisition action officer cannot depend on the users to provide such input; instead, he or she must proactively seek it.

One word of caution though: a program should not chase a user's rapidly changing requirements. Admittedly, the requirements target will always change or move somewhat, but program success requires at least relative requirements stability. Reflecting back on the enemies of obsolescence and changing requirements, "relative" stability means the time-to-capability must fall inside the time it takes the users to significantly change requirements. Even though the user community's desires or needs may have shifted slightly through a system's development, if a program maintains an ability to provide a valid product or capability in a *short timeframe*, e.g., inside the internal enemy's loop, the user will probably value the system, despite the slight change in requirements.

Unfortunately, the DoD regulations consider a "short timeframe" equal to about five years for a weapon system (DoDI 5000.02, 2008), which is an unacceptable amount of time. Technology and user needs could easily change drastically in five years. For instance, imagine user involvement at a CDR for an IT program after five plus years of development, trying to satisfy roughly seven year old requirements. Two possible outcomes of user involvement in such a slow process will transpire: either (1) the users will deem the requirement still valid, and they will walk away disgruntled because of the incomprehensible schedule delays in the program, or (2) the now *invalid* requirement will cause the user to not understand why the program continues unnecessarily wasting money and time on the system. Either way, the results increase the operating force's distaste for the acquisition process and reemphasize the need for rapidity and continual focus on user-defined value through the System Acquisition phase.

#### *c. Sustainment*

As the acquisition process winds down into the Sustainment phase and a system nears apparent completion, one might think the ability of a PMO to influence the process through RVEA also comes to a halt. However, this could not be further from the truth. The entire RVEA process emphasizes continual consciousness of value and improvement, but the Sustainment phase possesses the most logical mechanism for continuing value-addition and improvement in rapid fashion. The owners of the newly fielded systems have an opinion of the product and the process, and the program office merely has to capture this input and incorporate appropriate changes.

In the Sustainment phase, systems roll off the production line and eventually land in the hands of users in operational units. An acquisition action officer should liaise continuously with these units and users to maintain awareness of how or if the operators use the system. All too often, a PMO delivers a new system and provides initial operator training without ever attempting to learn from user experiences. Unadulterated user input during this introduction to the system can provide invaluable insight into areas worthy of potential improvement. Often the PMO wrongly holds an attitude of finality, and responds to user recommendations by saying, “The system is what it is and it’s not going to change until the next increment five years from now.” This unfortunate outlook promotes further customer dissatisfaction and gives meaning to cynical phrases such as *drive-by fielding*.

Opportunities exist beyond the initial fielding to gather user input as well. The operational unit accepting a new system will most likely be actively training or engaged in combat operations, either of which makes an ideal test bed for a newly delivered product. Action officers should make every effort to attend any training exercise utilizing a new system to capture any user recommendations and ideas for improvement, or just to gather opinions of the value the system offers. A unit in combat will not be as readily accessible as in training, but action officers should make and maintain contact with the system users to gather valuable operational insight which serves to guide subsequent improvements. Also, action officers should strive to meet with units returning from operational deployments as soon after their return as possible. Time quickly fades memories, both good and bad, and a program office must quickly capture any lessons learned relating to the system.

Additionally, acquisition officers must maintain close ties to the organization charged with supporting the system. System support can include follow on training, software patches, troubleshooting, help desk support, etc. Contractors or another government office such as the Marine Corps Tactical Systems Support Activity will likely accomplish these tasks which should include analysis of any trends observed in support of the system. This analysis can indicate areas implicitly needing improvement and can feed into requirements for future increments.

All of this gathering of information regarding an operational, fielded system wastes time and effort unless the program office applies it through a feedback mechanism that fosters continual improvement of both the product and the process. One mechanism to accomplish this occurs through reviews of future system increments. These reviews must make it a point to consider user feedback regarding previous increments and incorporate the most highly valued recommendations into future requirements. Such a valid feedback mechanism will ensure emphasis on value and continual product improvement, both of which will increase the probability of future program successes.

The process as well as the product in the Sustainment phase deserves attention in order to remain relevant and correctly focused. To insure the continued quality of the process, an action officer must make an honest, introspective analysis of the acquisition process. Some of the obvious questions to ask in order to follow the principles of RVEA are:

- Rapid: Was the process rapid enough to provide value to the user, and do future increments meet the user's required timeline?
- Value-based: Did the system improve the user's job, e.g., does the user value it?
- Evolutionary: Does the system readily support upgrades and changes?

The more revealing questions of, "Why?" or, "Why not?" must follow these types of yes/no questions. Reflecting back to the discussion of Boyd's OODA Loop, this analysis essentially accomplishes the steps of observe and orient. Or using Dr. Hayes-Roth's more detailed efficient thought model (reference Figure 4. ), they equate to observing and assessing the situation. The decision loops must not stop there though. To ensure effectiveness, action officers must close the loop by deciding upon desired changes; predicting outcomes; and selecting, communicating and implementing the best plan of action. Furthermore, until the organization either phases out or replaces the system, it must repeat and continually validate this cycle in rapid succession. Not doing so risks being overcome by the enemy of obsolescence and requirements change, eventually resulting in decreased system value and potential program failure. Such honest self-evaluation of the effectiveness of the acquisition process will enable a PMO to improve its acquisition process model which will produce more viable results in the form of increased user value.

Many may believe the Sustainment phase comprises the last of the acquisition phases and as such, a program office may choose to coast through system deployment and support with minimal emphasis on the principles of RVEA. In fact though, this phase offers great opportunities to refocus on rapidly providing the warfighter valued products, increasing the validity of future requirements, and improving the acquisition process. RVEA prescribes those very actions, emphasizing the fact that acquisition continues as more of a continuous cycle or loop than a process with a beginning and end. Missing opportunities for improvement in the Sustainment phase because of lackadaisical system support or an end-in-sight PMO attitude not only does a disservice to the warfighters, it potentially contributes to the demise of a once viable program.

The table below summarizes this discussion on the foundation and operation of RVEA. Following these acquisition rules of the road will help ensure rapid and improving value to the warfighter… measurable program success.

| DO | DO NOT |
|---|---|
| Identify & prioritize required and related attributes and functions. Priority should be based on value and time-to-build (difficulty) | Bite off on too much functionality at once |
| Measure availability of valued information ($A_{iv}$) of each function or service | Allow a vendor to lock the acquisition into a proprietary or inflexible product/process |
| Make noticeable improvements in the warfighter's job… if not possible initially, then make the system implementation as transparent as possible to the user | Decrease the value of the system by unnecessarily taxing the user's resources (time, weight, etc.) |
| Inject military specific requirements into developing COTS technologies and focus on COTS solutions as much as possible | Prolong service delivery by implementing serial development of successive functions before providing anything to users |
| Develop services in parallel, but start with those that offer the biggest bang for the buck, and work your way down the prioritized list | Stop looking for improvements once the system passes OT&E and begins fielding |
| Maintain awareness of and inject military requirements/raw technology into COTS developments | Make the users learn a new system without providing them value |
| Provide something of value to the user in less than 2 years after deciding upon a technology | Transition the technology to an acquisition program of record until it's mature |
| Continuously look for ways to improve not only the product, but the process | Assume the current acquisition system is too constraining or restrictive for RVEA |
| Design the system for evolvability | Be satisfied with the status quo |

**Table 2. Dos and Don'ts of RVEA**

## D. RVEA OF A USMC TACTICAL SERVICE ORIENTED ARCHITECTURE

Service oriented architectures have emerged as one of the various technical paradigms with great potential to help attain the goals for information sharing described in our national strategies (Lewis & Smith, 2007). Enterprise SOAs have benefited business entities in the private sector and, if successfully acquired, SOA can also benefit the DoD at not only the enterprise level of the military (DoDD 8320.02, 2004), but also the tactical level of warfighting.

### 1. What is SOA?

Referencing Figure 7 below, a generic SOA is a collection of services with well-defined interfaces and a standard shared communications model. A service usually exists as a discoverable, self-contained software entity that interacts with applications and other services through a loosely coupled message-based communication model. A service registry enables the discoverability of the entities that form services. Services exist as legacy or new software, and systems or users subscribe to the functionality provided by these services to achieve their purposes. For example, when a service consumer makes a reservation through a travel agency website, what appears as a single web-based application actually involves the complex orchestration of a set of services from various providers. These services could include user authentication, flight scheduling, hotel/rental car searches, reservations and credit card validation. Through services, SOAs offer the ideal of enabling legacy systems to interoperate, presumably without making significant changes (Lewis, Morris, & Smith, 2005).

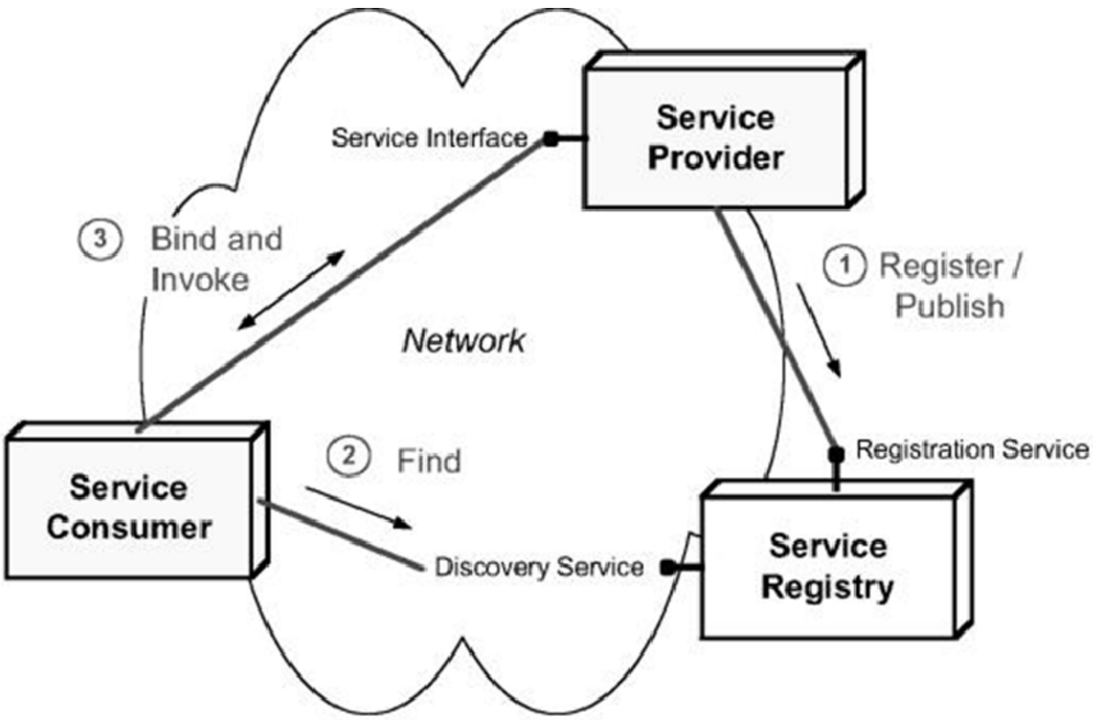


**Figure 7. Generic Service Oriented Architecture (Lau, 2007)**

This section will first point out some of the specific benefits espoused by SOA promoters and then make recommendations for applying the principles of RVEA to the acquisition of a Tactical SOA for the USMC.

Note the purpose of this section is not to wave a SOA flag, *per se*; rather it uses TSOA to illustrate a means to better manage the IT acquisition process through RVEA. IT investments should align with the principles of RVEA, and if a particular proposed technology contradicts these principles, the acquisition should consider another direction. For example, if one technology insists on keeping its proprietary nature and as a result does not offer sufficient flexibility to meet the demands for continual improvement, the program should investigate another possibility. Service oriented architectures run counter to such negative attributes as they lend themselves to natural developmental increments and openness while offering increasing capabilities in their services. A USMC TSOA acquisition program therefore appears more than suitable for the application of RVEA principles.

### 2. Benefits of a Tactical SOA

SOA offers many potential benefits to military applications, but perhaps none entice the DoD more than the prospective cost savings and technological agility, made possible due to the inherent reusability, flexibility and evolvability of SOA through vendor-neutral, open standards. Thomas Erl, acclaimed for his expertise on the SOA and the subject's best-selling author (ThomasErl.com, 2009), articulates other positives of contemporary SOA:

> Service orientation presents an ideal vision of a world in which resources are cleanly partitioned and consistently represented. When applied to IT architecture, service-orientation establishes a universal model in which automation logic and even business logic conform to this vision. This model applies equally to a task, a solution, an enterprise, a community, and beyond….
>
> The service-orientation ideal has sparked a movement that has positioned SOA as the next phase in the evolution of business automation. In the same manner in which mainframe systems were succeeded by client-server applications, and client-server environments then evolved into distributed solutions based on Web technologies, the contemporary, Web services-driven SOA is succeeding traditional distributed architecture on a global scale.
>
> All major software manufacturers and vendors are promoting support for SOA – some even through direct involvement in the development of open standards. As a result, every major development platform now officially supports the creation of service-oriented solutions. It would appear as though the realization of the SOA ideal is well underway. (Erl, 2005, pp. 3-4)

Table 3 lists some of the many benefits ascribed to SOA. Notice a few of these benefits appear performance-oriented, but the majority of them relate to the architecture's inherent flexibility: open, composable, agile, reusable, etc. SOA does not lock the implementer into a proprietary stovepipe, and it provides a sufficiently open model for disparate architectures to federate more quickly and usefully than earlier approaches. These characteristics of SOA and its popularity in the private sector indicate the increasing value organizations place on adaptability.

| *TSOA Benefits*<br>(Office of Naval Research, 2008) | *Contemporary SOA Benefits*<br>(Erl, 2005) |
|---|---|
| • Enables speed and flexibility to capitalize on new technology and business arrangements<br>• Reduces time spent to effect changes<br>• Provides the ability to leverage existing technology investments<br>• Minimizes the expense and complexity of integration<br>• Increases reuse<br>• Increases tactical agility | • Increases quality of service<br>• Based on open standards<br>• Fosters intrinsic interoperability<br>• Promotes architectural composability<br>• Is fundamentally autonomous<br>• Supports vendor diversity<br>• Promotes organizational agility<br>• Fosters inherent reusability |

**Table 3. Benefits of SOA**

### 3. Rapid, Value-Based, Evolutionary Acquisition of a TSOA

Since government acquisitions cannot realistically hope to “catch up” to the innovations of the private sector, the DoD must leverage the current state of the art including developments such as SOA to the best of its ability. Case in point, the enemy in the Global War on Terror performs netcentric command and control via modern mapping, imaging, discovery, and messaging services (etc.) available via the World Wide Web. Before the documented SOA benefits will ever materialize in the Defense Department, acquisition of a TSOA requires an improved process that concentrates on leveraging externally produced value. The current acquisition process, which often fails to provide anything of value to the warfighter, is causing justifiable apprehension as the USMC investigates acquisition of a TSOA. The Marines’ efforts to date toward TSOA include a feasibility study conducted by the Office of Naval Research (ONR), part of which included a draft technical description (TD) of the system[10] (Office of Naval Research, 2008). This document, although a draft, is thorough and continually referenced in this section. As an added benefit, it provides valuable insight into the details of TSOA development. Combining the sound technical recommendations of the TD with the principles of RVEA—rapid, value-based, and continual improvement through an evolutionary loop—will increase the chances of the USMC ultimately realizing the benefits SOA offers.

#### *a. Realizing TSOA's Potential Value*

SOA adds value to commercial enterprises as pointed out in the benefits listed above, but to narrow the focus this section discusses how to realize the potential value of *Tactical* SOA. The tactical aspect of TSOA involves making information services available to the lowest tactical level possible, or the organizational edge as described by the private sector. The warfighter or edge users of TSOA will sense its value initially through improvements in their ability to perform currently existing tasks. More importantly though, TSOA will help promote future gains in value through its inherent evolvability… assuming an acquisition process that concentrates on continual improvement.

Depending on the first services deployed, TSOA will probably not provide any apparently new or revolutionary functionality, but it will allow the users to do their job more efficiently and effectively because of easier access to and potential filtering of information. Networks supporting the tactical edge must address two daunting challenges: the operators require great mobility while, at the same time, they must operate with very limited communications bandwidth TSOA must therefore embrace concepts such as Valued Information at the Right Time (VIRT) to insure against dreaded info-glut and a potentially gridlocked network (Hayes-Roth, 2005). TSOA, once deployed, will reduce the number of

[10] The analysis performed for the TD was part of the Advance Fires Coordination Technology, Future Naval Capability program, which was sponsored by the Office of Naval Research (ONR) under the technical direction of the Naval Surface Warfare Center, Crane IN.

specialized systems requiring their own hardware, which will reduce weight and power consumption. Additionally, the architecture will provide an open framework upon which future technologies and services can build.

After initial implementation and establishment of the underlying framework, TSOA will evolve, incorporating services which will combine to provide the same apparent functionality as current stovepipe tactical applications. Unlike the legacy applications though, TSOA will ideally enable information sharing through semantic interoperability between the services comprising the tactical applications. Describing TSOA's desired end state, it will eventually hosts interoperable services for most if not all of the USMC warfighting functions of fires, maneuver, intelligence, command and control, logistics, and force protection.

To better illustrate this notion, Table 4 lists some current tactical applications, most of which vary greatly in levels of complexity and functionality. TLDHS and PFED, for example, have fairly limited application compared to the large and complex TBMCS. Each of these applications would subscribe to multiple distinct yet reusable services residing on a TSOA. A particular legacy application's functionality and complexity would determine not only how many and which services comprise the application, but also their level of reusability between applications. For instance, PFED, AFATDS, NFCS and TLDHS share some requirements as target entry devices/applications for the fires chain. Each could therefore potentially share a common '*target recording'* service since each system would utilize common target attributes such as location and elevation. However, each application would require a unique '*fires request'* service because the different firing platforms of artillery, CAS aircraft, and naval gun fire (NGF) all have different request formats. This illustrates the concept of common, reusable services bundled together with unique services to provide tactical application functionality.

| |
|---|
| Advanced Field Artillery Tactical Data System (AFATDS) |
| Command and Control Personal Computer (C2PC) |
| Joint Automated Deep Operations Coordination System (JADOCS) |
| Mobile Electronic Warfare Support System (MEWSS) |
| Naval Fire Control System (NFCS) |
| Pocket-Sized Forward Entry Device (PFED) |
| Target Location, Designation, and Handoff System (TLDHS) |
| Theater Battle Management Core Systems (TBMCS) |
| Web-Enabled Execution Management Capability (WEEMC) |

**Table 4. Some Tactical USMC Applications**

Although the TD does not imply that the fires chain should take first precedence for inclusion in a TSOA, it studies fires as an example because of its stringent requirements for timeliness, correctness, and conciseness. Incidentally, because of these attributes and its complexity, the fires chain is also probably one of the most difficult warfighting functions to successfully develop and host on a TSOA. The program officers, developers, and users should prioritize all required services in terms of not only user value but also technical difficulty and implement the ones that provide the most value with the least amount of difficulty—the so-called low-hanging fruit. After providing rapid initial value, the acquisition process must build upon this success to develop increasingly difficult or somewhat less valued services. To reiterate the principles of RVEA, the TSOA acquisition must not attempt to provide too much functionality in a single step, but instead should focus on rapid iterations of valued improvements.

The TD appropriately recommends both operational and technical metrics, including latency, reliability, interoperability, and flexibility, among others. However, one measure of value the TD overlooked includes a metric of information value, such as the aforementioned $A_{iv}$, which compares the number of bits that actually provide value to the total bits transmitted. For instance, in the fires chain such valued information includes the bits that positively contribute to ultimate target prosecution, such as those defining a target's location, elevation, etc. This illustrates the fact that a service's value comes from (1) delivering information that enhances the warfighter's mission accomplishment, and (2) avoiding distracting the warfighter with insignificant information. TSOA must measure and guarantee value of the information flowing over the network using metrics such as $A_{iv}$.

The commercial IT market has much to offer the DoD; unfortunately, however, most COTS technologies do not meet some of the most stringent government requirements for Information Assurance, with respect to authentication, non-repudiation, confidentiality, integrity, or information availability (DoDI 8500.2, 2003). The TD points out that SOA technology is not at the level of maturity required for a simple COTS purchase of a Tactical SOA. It outlines three options for increasing the maturity of TSOA and then recommends one option in which the USMC takes the lead in adapting enterprise SOA to create TSOA. Another viable option for developing and steering COTS technologies being studied by the W2COG smartly leverages the commercial market to better address specific military and government requirements. This option explores an hypothesis which states that if the government

> (1) continuously develops and furnishes critical **raw technology** to the industrial base; and (2) simply publishes its use cases, objective selection criteria, and COTS competitive procurement budget in lieu of formal Engineering Development Model-type solicitations; then continuing industrial competition will generate pure COTS offerings that are ever more aligned with government requirements. (Gunderson & Minton, 2009)

Raw technology in the case of a 2008 W2COG demonstration[11] included security services such as authentication and authorization for web services. After the interoperability trial, the W2COG exhibited the viability of the above hypothesis by demonstrating the streamlined procurement of a substantial and supportable network capability upgrade. This same approach deserves application in conjunction with RVEA to the acquisition of TSOA to enable additional value.

#### *b. Rapidity and TSOA*

To avoid a prolonged development period that risks being superseded by changing requirements and technology obsolescence, TSOA should not transition to an acquisition program of record now, considering its low level of maturity. Instead, it should remain under the cognizance of S&T organizations such as ONR while the Marine Corps and other interested entities inject their requirements into the maturation process.

Furthermore, as mentioned, the tactical edge involves operations using limited bandwidth. Much of a TSOA's connectivity depends on overcoming or adapting to this limitation through related acquisition programs such as the Joint Tactical Radio System (JTRS). JTRS will potentially serve as an enabler for improved network operations including TSOA, and it will most likely deploy to the lower tactical levels no sooner than about 2015 (Office of Naval Research, 2008). The TSOA effort should synchronize with these enabling technologies and ensure sufficient preparation to establish its underlying framework along with basic valued services upon their deployment. This does not imply that TSOA should wait for JTRS fielding, rather that TSOA should continue to develop in parallel with its enabling technologies. Parallel development would require increased agility such as through building on a commercial communication suite comparable to JTRS while planning for eventual transition to a tactical system.

[11] Coalition Warrior Interoperability Demonstration 2008, Interoperability Trial (IT) #5.64 "Trusted Enterprise Service Bus" (T-ESB) demonstrates a potentially quantum improvement in the government procurement model for information systems. Joint Interoperability Test Command (JITC) sponsored the World Wide Consortium for the Grid (W2COG) Institute (WI) to conduct IT 5.64.

Once realized, the basic TSOA should develop and incorporate additional tactical services rapidly, continuously capitalizing on lessons learned from previously deployed services to expand its capability and value. Throughout this iterative process, the Marine Corps must maintain keen awareness of developments in the SOA industry as well as the military's S&T centers. Additionally, as mentioned above, the program office must constantly evaluate and prioritize candidate tactical services based upon their value and difficulty. This process of reassessing and retargeting against a moving target will help ensure rapid delivery of TSOA value.

Although realization of TSOA in six years does not seem "rapid," this recommendation is consistent with the principles of RVEA. Considering the rate of change of technology, six years equates to about three technology generations, during which new discoveries and innovations will occur and requirements will change. The USMC should allow technologies to go where they may and attempt to steer or leverage their direction by feeding military-specific requirements and interests to industry, instead of setting its sights on a target six years in the future. Additionally, the USMC must consider the schedule risks of TSOA's enabling technologies, such as JTRS, that do not necessarily subscribe to RVEA principles. Any slippage of one of these programs induces a proportional delay in TSOA.

#### *c. Continual Improvement of TSOA*

TSOA and its associated acquisition program intuitively support continual improvement because of a natural divisibility into incremental service acquisitions. Additionally, the architecture's inherent beneficial attributes such as reusability and modularity could logically play a part in the program's efforts toward improvement. One could even say SOA helps enable continual improvement because of its intended basis on open standards that (1) do not lock the DoD customer into a single, proprietary solution, and (2) offer flexibility to change vendors midstream if the acquisition process requires it. However, these benefits will not happen automatically and without effort from those in charge. The program office must continue to focus on the principles of RVEA in order to realize the benefits of TSOA.

Continual improvement of a TSOA product requires rapid iterations of increasingly valued capabilities. The underlying open framework of TSOA will not provide immediate value to the user by itself. TSOA's value will come from the valued services developed for and available to the warfighter, which reside on the framework. For example, the basic functionality of TSOA must include authentication and authorization services with the implementation of the framework. But TSOA and these services alone provide no apparent functional value for an operator. Instead, the value will arrive in the form of *useful* operational services discoverable to the operator. For this reason, the value of TSOA hinges on the rapid development, implementation and continual improvement of tactical services residing on the underlying framework.

A PMO must consistently evaluate its internal processes and feedback mechanisms to help guarantee continual improvement of the TSOA acquisition process. The program office must keep a finger on the pulse of COTS IT to ensure continued awareness of commercial best practices/technologies. Likewise, the government must also inform the commercial IT industry of government interests, requirements and raw technologies. Such shared awareness will allow government IT acquisition to better leverage the COTS IT vector which will ultimately increase the supply of potentially viable products and TSOA services to meet tactical military needs. These efforts will help a TSOA program effectively keep up with Moore's Law instead of being beaten by it. The USMC and DoD must manage IT acquisition, especially COTS, in such a manner as to enable and not hinder its tactical objectives, to include information superiority to the tactical edge through TSOA.

As the last point for continual improvement during TSOA's acquisition, the USMC must not put all of its proverbial eggs in a single TSOA basket, inextricably tying itself to a technology that could end up dying on the vine. Future innovations may lie right around the corner and could render SOA obsolete in its attempt to reach the tactical edge. A TSOA acquisition program must be ready, willing and able to retarget on a new technology if necessary. Staying in touch with commercial developments means maintaining an awareness of not only the world of SOA, but also any other potential COTS solutions that could benefit the organizational edge. Technologies or protocols just beyond the near future of IPv6 and fourth generation wireless could potentially leave SOA obsolete by providing superior remote, edge access to network services and functions. Program offices must write acquisition strategies and their associated contracts in a manner to allow such direction change, and RVEA demands short cycle times to allow continual improvement and refocusing on not-so-distant targets. A new target could mean writing off TSOA sunk costs and killing the program if it would benefit the warfighter. After all, sometimes benefit comes in the form of <u>not</u> fielding a new system.

# IV. SUMMARY

## A. CONCLUSION

Cost overruns, schedule delays, and performance shortfalls have plagued defense IT acquisition projects since the acronym IT came into existence, and they continue to do so today. One can attribute at least part of this crisis to a lack of a clear definition of program success. In its most simple form, program success means providing the customers something they value; likewise, providing no value to users signals program failure. Even though they have worthy intent, without such a clearly defined goal, acquisition commands will continue to deliver users their best attempt at a solution and often still fail to satisfy operational needs. General blame for such failure traces back to either a shortfall of the system itself or a lack of timeliness of acquisition and fielding. A late system can easily mean an ineffective system that lacks user value because of requirements change or technology obsolescence. These points succinctly answer two of the secondary research questions proposed at the beginning of this thesis: (1) What defines acquisition project success and failure, and what causes a project's failure? (2) How does the concept of timeliness fit into the equation for acquisition value?

As a potential solution to many of these problems, RVEA focuses on three primary factors that can help improve the Defense acquisition process: rapidity, user-defined value, and continual improvement through system and process evolution. These factors answer the primary research question of this thesis: What essential principles enable acquisition programs to deliver valued capabilities successfully to the warfighter?

The value basis of RVEA stems from user involvement in the acquisition process from the cradle to the grave. In order to provide value to the IT system user, or the warfighter, acquisition programs must identify and understand exactly what the user values. Even though broad requirements trickle down from upper-level DoD leadership, a program office must intimately understand user-defined value through proactively seeking and maintaining user involvement in the process… admittedly not an easy task. Despite their taxing operational commitments, the voice of the warfighters who will experience the acquisition product hands-on must consistently resound through system design, development, testing, manufacturing, fielding, and sustainment. Such involvement ensures the system will meet the users' expectations for not only the typical quality metrics such as usability, reliability, and supportability, but also the timeliness of the acquisition. The risk of not doing so spells ultimate program failure due to an irrelevant and unvalued product.

Rapidity and Defense Acquisition used in the same sentence regrettably has the ring of an oxymoron. If the DoD hopes to field relevant, operationally effective and suitable systems, the acquisition process's speed must increase significantly. The current process often fields outdated products because IT—and incidentally its associated obsolescence—pervades most systems charged with supporting the USMC's six warfighting functions. The rate of obsolescence outpaces the current speed of acquisitions partly due to acquisition programs attempting to provide too much functionality in a single step. Considering the current pace of innovation and technological advancement, procurements should concentrate on selecting the least difficult and highest value solutions currently available, which often materialize as COTS. The least difficult solution implies one readily available, mature, and proven in a relevant environment if at all possible. Accepting anything less can easily lead to schedule delays resulting from a prolonged development phase… quite the opposite of rapid acquisition, and a glaring opportunity for the enemy, obsolescence. Warfighters expect current, useful technology and abhor outdated and consequently unnecessary equipment. By focusing on rapidity—providing small yet high value improvements to the warfighter in rapid succession—a program increases its chances of success.

The aspect of continual improvement in the context of RVEA means methodically evaluating past accomplishments and failures, both in product and process, and applying lessons learned from these evaluations to future actions. This ongoing process requires rapid iterations of a recognized, formal feedback mechanism using appropriate value metrics, as well as a focus on quick solutions. Future solutions or targets should remain as near in the future as possible since distant targets (requirements) move unpredictably and often. Quantifying “near” as it relates to IT suggests delivering an improvement within two years of deciding upon a technology. Continual improvement demands subsequent evaluation of the solution’s results and rapid application to not only current and future products, but the processes of acquiring and supporting them as well. Such rapid, short term retargeting will help decrease the number of programs that miss their mark due to aiming at much too distant targets. Additionally, in order to increase the number of options available as potential acquisition solutions, the DoD must inject its interests, concerns and requirements into the mainstream COTS marketplace. As militarily useful COTS products become available, the acquisition process must apply the process of continual improvement to them, promoting and capitalizing on the ones that work and discarding the ones that do not.

A tactical service oriented architecture offers the USMC value in its supposed flexibility and potential long-term cost savings. Additionally, once in place, it offers increased technical agility and decreased development time of future tactical services and applications. These attributes align with and positively support the principles of RVEA, and TSOA is therefore well suited for the application of RVEA.

Figure 8 provides a diagram to help summarize the answer to the remaining secondary research question of this thesis that asks how the USMC should exploit the principles of rapid, value-based, evolutionary acquisition for the development and procurement of a TSOA? RVEA and TSOA’s acquisition first require relevant demonstration of the maturity and value of the technology by the

S&T community.  This must include proving the readiness of not only the underlying SOA framework and the most basic required services, but also the highest priority tactical service(s) offering the greatest “bang-for-the-buck.”  Only after successful demonstration should the technology then transition to an acquisition program of record, aiming to provide the highest value, least difficult services to the warfighter in less than two years.  Once established as an acquisition program, rapidity will help ensure victory over the enemies of obsolescence and requirements change.  Throughout the process, the program office as well as the S&T community must constantly engage user representatives to ensure the requirements, current system design, and future increments remain valid.  Meanwhile, the next iteration of the entire process should already be underway, focusing on improvement and having adjusted its aim onto not-so-distant targets according to the inputs of a formal, methodical and continuous feedback mechanism originating from user-defined value.  Such an acquisition process would increase the likelihood of success of most IT acquisition programs, especially a TSOA.  In summary, TSOA holds potential benefit for the Marine Corps, but only if we develop and procure it using principles such as those embraced by RVEA.

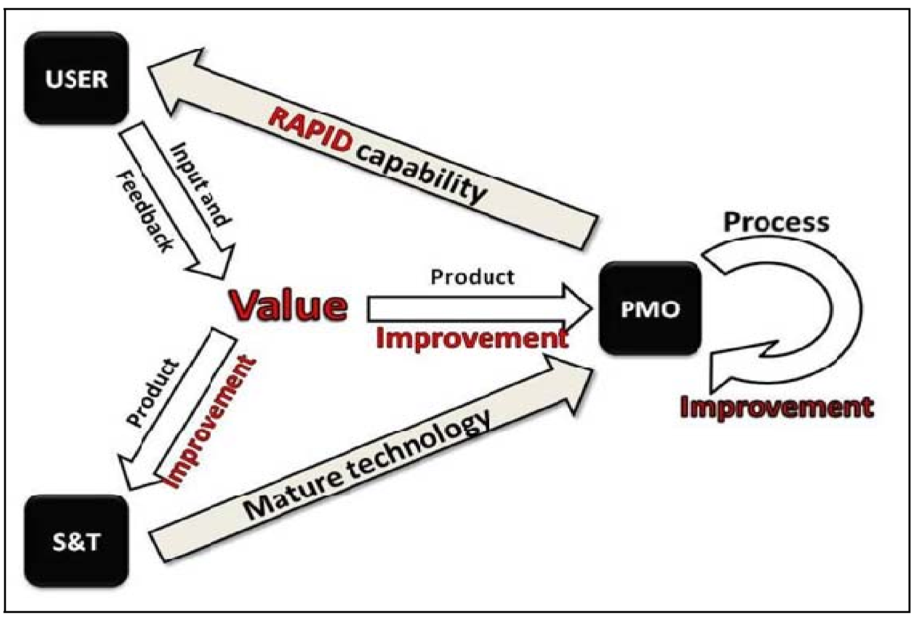


**Figure 8. RVEA Process**

## B. RECOMMENDED FUTURE RESEARCH

The research for this thesis and its subsequent writing uncovered some areas for future work which might prove useful to the DoD.

### 1. PPBES and RVEA

The DAS has undergone many changes over the past two decades in response to the arrival of the information age. The system has adapted in an attempt to meet the challenges associated with acquiring increasingly sophisticated equipment and capabilities. The PPBE system, however, has not sufficiently changed to meet these challenges and has become a hindrance to the progress of acquisition. While RVEA stresses speed, flexibility and efficiency, the PPBES does not, and the two therefore appear ill-suited for each other. Research and recommendations to increase the PPBES's rapidity and responsiveness for acquisition programs would greatly benefit the field of Defense IT acquisitions. This, however, is no small undertaking and would most likely involve statutory and regulatory changes. Assuming the federal government will someday revamp the PPBES, this research could prove valuable as a precursor to such an effort.

### 2. Cost-Benefit Analysis of USMC SOA

Trying to capture quantifiable costs and benefits presents difficult challenges, at best, in the public domain where emphasis is not on profit. Analysts can measure some costs directly but other distantly related and sometimes expensive side-effects evade even the best cost analysts. Benefits present an even great measurement challenge, especially in the military, due to the fact that, for example, sometimes benefit lies in the number of lives or limbs saved… a metric nearly impossible to apply a dollar figure to. A cost-benefit analysis of a USMC SOA would therefore be a challenging, yet valuable, thesis opportunity. Such an analysis could involve either a TSOA or a more administratively focused enterprise SOA. The comparison could measure time saved by the user, accuracy of data, and personnel metrics, to name a few.

### 3. Establishing a Formal Beta-Test Community

As this thesis points out, user involvement in the acquisition process helps define system value and contributes to program success. Such user involvement, though, is often extremely difficult and expensive to coordinate due to the time-constrained schedules of the user community. Operational commitments, both in continental U.S. training and overseas combat, tax tactical system users sometimes to a point of 16+ hour days, 7 days a week. A formally established tactical beta-test community of users could help alleviate this problem. This community could stand up as a mini-battalion, for example, with a sampling of various combat arms MOSs. Assignment to this unit would require the Marines to have recent operational experience in their MOS, and they would serve there for a minimum of two years. The unit would provide system testers and user representatives as dedicated direct support to the acquisition community. The recommended research could investigate the feasibility of establishing such a beta-test unit and complete a cost-benefit comparison on it.

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